

DECLARATION OF LAWRENCE STILWELL BETTS, MD, PhD

I have been asked by legal counsel to expand my discussion of several areas which I have previously addressed in trial and deposition testimony, and in prior declarations, affidavits, and reports. To this end, I, Lawrence Stilwell Betts, MD, PhD, CIH, FACOEM, declare that:

1. I retired from the United States Navy as a Captain in 2001, and now have a very active professional practice in science and medicine based in Poquoson, Virginia. As reflected in my Curriculum Vitae (Betts, 2012), I am the President of my own medical and scientific practice. I routinely consult on, or work with, difficult and complex medical cases where treatment, or exposure or possible consequences of exposure, are in question. My professional associations include a wide variety of government, industry, and professional organizations, as well as academically – and privately – practicing professionals. I also teach, mentor, perform research, develop prevention and treatment protocols, and write medical articles and text chapters. I am a Clinical Professor at the Eastern Virginia Medical School where I have had a continuous academic relationship and have been teaching toxicology, previously with the approval of the US Navy while I was on active duty, since 1979. I serve on several national committees addressing broad, as well as specific, issues in occupational and environmental health. I am board certified in both occupational medicine by the American Board of Preventive Medicine, and in the comprehensive practice of industrial hygiene by the American Board of Industrial Hygiene. Together with the late W. Clark Cooper, MD, and Mitchel R. Zavon, MD, I am one of the original three “medical scientists” to have ever been elected to Fellowship in both the American College of Occupational and Environmental Medicine and the American Industrial Hygiene Association; a fourth, Sidney Siu, MD, was recently added to this short list of physicians who are also Certified Industrial Hygienists, in 2012. The anticipation, recognition, evaluation, and control of hazardous conditions are the fundamentals of industrial hygiene and my practice of preventive medicine and public health. The emphasis of my entire career has been the prevention of illness and the promotion of health through the application of the professional tools of my scientific and medical knowledge and experience. After my retirement from the US Navy, I was presented the VADM Richard A. Nelson Award for my career contributions to Navy and Marine Corps readiness through leadership in prevention of disease and promotion of health.

2. During my Navy career, I was assigned to billets with professional duties and increasing responsibilities, initially as a scientist in industrial hygiene and toxicology, and later as an occupational and environmental medicine physician and medical toxicologist. I became one of the first physicians to qualify and be designated a Surface Warfare Medical Department Officer (SWMDO). I have spent time at sea on a large number of United States Navy and United States Naval ships and I have worked in and directed occupational health programs at Naval shipyards, air rework facilities, weapons stations, and other major shore facilities in the San Francisco Bay area and the Tidewater area of Virginia. I served as a physician on the USS KITTY HAWK (CV-63) during her extensive Service Life Extension Program (SLEP) in the Philadelphia Naval Shipyard from 1987 to 1989. Based upon my scientific and medical training, and experience as a Navy officer for three decades, and now as an active governmental consultant for over a decade, I am generally familiar with the industrial products that were used by the Navy and in maritime work environments, both ashore and afloat. I am also familiar with the history and practice of the Navy occupational health program from its early days before World War II until the present time. During the four decades of my professional life, I have also become familiar with, and evaluated occupational exposures to, asbestos-containing and other materials used in the electrical trades, aircraft and aerospace industries, nuclear power facilities, and several other trades and industrial/commercial activities which are not unique to the Navy or maritime industries.

3. Based upon my scientific and medical training, and experience as a US Navy officer for three decades, I am familiar with the Navy mission, the Navy command structure for Navy active duty and civil service personnel, the maritime work environments, both ashore and afloat, and the industrial products and equipment that were used in shipbuilding applications. I am also familiar

with the history and practice of the Navy occupational health program from its early days before World War II until the present time.

4. I have been asked by counsel to address the following issues based upon my knowledge, experience, and research, and to report my findings and conclusions:

- a. **What are the fundamental missions of the United States Navy (US Navy; Navy) and the Navy Medical Department, and how is the Navy organized to fulfill those missions?**
- b. **What role did asbestos (primarily as used in thermal insulation products) play in Navy and maritime shipbuilding and maintenance during the period from before WWII through the enactment and implementation of the Occupational Safety and Health Act (PL-91-596) in the 1970s and thereafter?**
- c. **What did the Navy and other Federal Government Departments and Agencies, private shipyards and employers, as well as organized labor, know regarding the health hazards of asbestos during this time period? Additionally, how did this knowledge affect the use and handling of asbestos during the post-OSHA era?**
- d. **Was there additional occupational health information about asbestos, available during the relevant periods of time, which should have been provided by an equipment manufacturer or vendor supplying a product to the Federal Government in accordance with specifications, or to a private industrial or maritime employer, that would have meaningfully enhanced existing knowledge, and that would have been likely to alter established specifications, policies, and procedures regarding the use of asbestos-containing products and materials?**
- e. **In fulfilling its mission, did the Navy engage in “risk-balancing” between issues critical to mission success and the risks of asbestos exposure to the health of Navy Department personnel – both active duty and civilian?**
- f. **Whether, and to what extent, Navy and shipyard personnel during the 1940s through the 1970s typically were exposed to meaningful amounts of inhalable asbestos dust onboard ships?**

5. I have based my professional opinions contained in this report on my Navy and professional knowledge arising from my training, education, and experience as a scientist, physician, and, now retired, senior United States Navy officer, as well as my extensive research regarding the knowledge of, and response to, asbestos hazards within the Navy and shipyards specifically, and more generally within the scientific and medical communities at large.

MISSION AND ORGANIZATION OF THE US NAVY AND NAVY MEDICAL DEPARTMENT

6. Although the wording of the mission has changed and evolved over time, the Navy currently describes its mission as the following:

“The mission of the Navy is to maintain, train and equip combat-ready Naval forces capable of winning wars, deterring aggression and maintaining freedom of the seas.” (USN, 2010)

The Navy’s mission is carried out as an integral part of the overall strategy of the Department of Defense:

“Current U.S. defense strategy calls for continuing to shape the strategic environment to advance national interests, maintaining the capability to respond to the full spectrum of anticipated current threats, and preparing for the threats of tomorrow. Implementation depends on the fundamentals of military power: quality people, ready forces, and superior organization, doctrine, and technology. The challenge is to construct an effective defense establishment with limited financial resources in accordance with Department of Defense guidance.” (NAS, 1998)

In order to fulfill its mission, the Navy must be authorized the funds and personnel to develop and maintain resources – the technology, equipment, conditions – to enable its forces. The Navy maintains a ready and capable force in mind, spirit, and equipment so that personnel are able to respond, when called upon, to a variety of events. In addition to actual combat with a hostile enemy, the Navy must also be able to respond to natural disasters, humanitarian situations, and political events. When not responding to actual combat, the Navy devotes its assets (people, equipment, and funds) to maintaining a state of preparedness and readiness which allows it to be adroit in responding to any mission. Whether at war or in peace, the Navy is always engaged in or preparing for its role in National defense.

7. The ultimate role of the Navy is the projection of force upon the seas as the naval warfare service branch of the armed forces. To this end, the Navy must maintain a constant state of readiness. This is achieved through the maintenance and preparation of ships, aircraft, and equipment, and supporting the shore activities, as well as the personnel manning and operating these activities. The preparation is accomplished through such activities as maintaining and repairing ships, aircraft and other equipment; health promotion and maintenance; equipping and training personnel; developing new technologies – both defensive and offensive; logistics; and budgeting. Without logistics and other support activities, combatant forces (ships, aircraft and personnel) cannot sustain a mission.

8. Even before the United States entered WWII, the Navy Medical Department’s express mission was:

“To keep as many men at as many guns as many days as possible.”
(BuMED, 1941)

Currently, this mission statement is not as “combat specific” as manning guns, but still the Navy’s Medical Department’s primary mission is stated as:

“OUR MISSION IS FORCE HEALTH PROTECTION. As the preeminent maritime medical force deployed with our Navy and Marine Corps warriors throughout the world, we are capable of supporting the full range of operations from combat to humanitarian assistance. We are further capable

of providing superior state of the art in-garrison health and preventive care for active duty personnel, our families and those who have worn the cloth of our nation – our retirees.” (BUMED, 2009)

In support of the Navy's mission, the Medical Department promotes and maintains the health of personnel through the care and treatment of sick and injured members of the Naval service and its civil service employees; prevention and control of diseases and injuries; promotion of physical fitness; as well as performing training and research programs. If people cannot operate the equipment or otherwise perform their duties, ships could not get underway, aircraft could not fly, and other vital operational aspects of the Navy's mission could not be performed in support of national defense.

9. Under civilian leadership (the President, the Secretary of Defense, and the Secretary of the Navy), the Chief of Naval Operations (CNO) is the senior Naval officer with responsibility for every aspect of the overall operations of the Navy. The CNO is a four-star admiral and is responsible to the Secretary of the Navy for the command, utilization of resources, and operating efficiency of the operating forces of the Navy and of the Navy shore activities assigned by the Secretary. As a member of the Joint Chiefs of Staff (JCS), the CNO is the principal Naval adviser to the President and to the Secretary of the Navy on the conduct of war and is the principal adviser and Naval executive to the Secretary on the conduct of activities of the Department of the Navy. Assistants include the Vice Chief of Naval Operations (VCNO), the Deputy Chiefs of Naval Operations (DCNO), the Assistant Chiefs of Naval Operations (ACNO), and a number of other ranking officers. These officers and their staffs are collectively known as the Office of the Chief of Naval Operations (OPNAV). In addition to the “war fighting members” of the office of CNO, the Navy Surgeon General (SG) and others, such as the Chief of Chaplains and Chief of Information Dominance, also serve to advise the CNO in matters under their cognizance. The SG serves a dual role in the Navy as both the principal advisor to the CNO on medical matters and also the head of the Navy's medical department (Chief, Bureau of Medicine and Surgery (Ch, BUMED)). The CNO may consult with the SG on medical matters; however, the final determination on overall operational strategy and mission achievement rests solely with the CNO (subject to consent of civilian leadership) (USN, 2010).

10. Prior to the 1970s, the Navy's health and safety functions were separately operating components. This initially started in 1917 with the establishment of the safety engineer at shipyards, and then later with the establishment of medical officers at shipyards in the 1920s. The fundamental advisory role of the Navy Medical Department was “medicine” or “health” – not physical safety (such as prevention of trips and falls; “guards” for tool safety). The “Basic Rule of Responsibility” states (CNO, 1953):

“Safety is a command function. Responsibility for the safety of personnel is vested in the commanding officer.”

The complete text of this rule not only appears in Chapter 1, but is reprinted on the title page of each chapter of the 1953 “United States Navy Safety Precautions”.

11. The Naval chain of command is the Service's delineation of “authority, responsibility, and accountability” extending from top Navy civilian leadership (Secretary of the Navy) through all levels of Naval command or “supervision”, and to all Navy personnel. From the day of entry into Navy service, all Navy personnel are taught and must strictly adhere to the chain of command. Using the chain of command, all personnel receive their orders (assignments) and supervision from their immediate senior or “supervisor” in the chain of command. This command structure is important to fulfilling the Navy's mission because it (a) defines authority and responsibility from the most senior to the most junior person in the Service; (b) establishes administration, support, communication, and discipline; and (c) organizes forces to carry out operations. The importance of the chain of command to the Navy's mission is demonstrated by the applicable disciplinary actions for Navy personnel who fail to carry out lawful orders from a senior within the chain of

command. A significant breach in the chain of command could endanger personnel or equipment, mission completion or success and, ultimately, the national defense.

12. It is ultimately the Commanding Officer's responsibility to ensure that all personnel and equipment, which includes ships, aircraft, and other physical resources, are prepared to operate and perform their functions in support of their assigned mission. The maintenance of good order and discipline is essential to the Commanding Officer's ability to meet his/her responsibilities. If Navy personnel do not follow the military chain of command and perform duties as directed by his/her operational superior, or if civilian "third-parties" are permitted to interfere with the Navy command structure, Navy operations and mission could be endangered. This is simply because the Commanding Officer would not have confidence that his/her orders would be followed and, ultimately, that the Navy's mission objectives would be met.

13. As I discuss more fully below, the Navy established a comprehensive occupational health program that operated within the overall chain of command to communicate medical and hazard information. Whether onboard combatant vessels or in Navy yards or other shore facilities, the Commanding Officer is charged with protecting the health of all Naval personnel and civilian employees (as appropriate) under his/her command. Navy Medical Department officers working under a Commanding Officer have the responsibility for identifying and communicating information regarding occupational health hazards.

HISTORY OF KNOWLEDGE AND CONTROL OF ASBESTOS HEALTH HAZARDS BY THE US NAVY, AND IN US SHIPYARDS

14. With respect to naval and maritime activities, as well as general industry in the United States, the US Navy and the US Public Health Service (USPHS; PHS) have cooperated in evaluating asbestos exposures and developing exposure control methods for almost three-quarters of a century. The US Public Health Service was established by Congress in 1798 as the provider of health services for the US Merchant Marines – initially as the Marine Hospital Service; later the Public Health and Marine Hospital Service; and currently the Public Health Service. At the request of the North Carolina State Board of Health and their Industrial Commission, the US Surgeon General assigned Dr. WC Dreessen and his co-workers from the Public Health Service to perform the first such evaluation of the developing asbestos textile industry in the United States. (Dreessen, 1938). Dr. Dreessen, together with another senior physician in the Public Health Service, Dr. RR Sayers, disseminated these findings at the American Public Health Association meeting in 1938, and later published them in the *American Journal of Public Health* in 1939 for the general scientific and medical communities. Later, at the joint request of the US Navy and the US Maritime Commission, Dr. Dreessen worked with Prof. Philip Drinker and Dr. WF Fleischer, a Navy physician, on an asbestos exposure evaluation and development of asbestos exposure control methods and medical practices for employees at a private US shipyard. (Dreessen and Fleischer, 1944) A discussion of "what and when" the US Navy was aware of regarding the health hazards associated with asbestos and the need to control exposure to airborne asbestos fibers is thus forever intertwined with the "what and when" of the US Public Health Service's parallel awareness and understanding regarding the protection of the health of the general public – and civilian mariners.

15. The Navy's development of nuclear power for ship propulsion systems in the late 1940s led to a close working relationship and the sharing of information between the US Navy and the US Atomic Energy Commission (AEC) – as well as the Public Health Service. The AEC later "evolved" into the Nuclear Regulatory Commission (NRC), the Energy Research and Development Administration (ERDA), the Department of Energy (DOE), and the National Nuclear Security Administration (NNSA). These organizational entities always had a close working relationship with the Navy's Bureau of Ships (BuSHIPS) and the Office of Naval Reactors. A close relationship still exists today between the US Navy and non-Navy ("civilian") Governmental

Departments and Agencies through the Navy-Department of Energy Naval Nuclear Propulsion Program. A working relationship also existed between major US Governmental Departments and Agencies and the energy utilities with respect to occupational health and safety. This relationship was enhanced by the presence of two notable individuals: Admiral HG Rickover, USN and HE Stokinger, PhD. ADM Rickover served in joint and overlapping assignments with the US Navy and the early AEC--such as in his roles in the Division of Reactor Development at the AEC and as Director of the Naval Reactors. These roles led to his direct involvement with both the development of the Navy's first nuclear-powered vessel, the submarine USS NAUTILUS which was commissioned in 1954, and also the Shippingport Atomic Power Station which powered up on December 18, 1957 as the first commercial, pressurized water reactor nuclear power plant. Dr. Stokinger served initially in the Industrial Hygiene Section on the Manhattan Project with the Atomic Energy Commission, and later, in 1951, he became the Chief Toxicologist for the newly created Division of Occupational Health of the US Public Health Service. Dr. Stokinger continued with the Public Health Service until well after the enactment of the Occupational Safety and Health Act in 1970 and the establishment of the National Institute for Occupational Safety and Health (NIOSH). He served on the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) Committee for twenty-five years--fifteen of those years as the Chair. The US Navy had representation in the ACGIH and also on the TLV Committee. As discussed throughout this report, the Navy's knowledge of the applications and hazards of asbestos represented what was available and known by other Federal Departments and Agencies

16. The Navy and the Maritime Commission's use of asbestos onboard ships generally, and on steam systems specifically, was not by chance, nor based on any requirements of the Navy's equipment manufacturers and vendors. The use of asbestos was based upon necessity. Due in large part to the association of one notable individual, Professor Philip Drinker of the Harvard School of Public Health -- and who also served as the Chief Health Consultant for the US Maritime Commission, the knowledge and experience possessed by the Navy regarding the use of asbestos since its early use in steam-generating systems, as well as the hazards and means of controlling those hazards, was shared and held by other Federal Departments and Agencies. As discussed in their landmark paper addressing the use of asbestos in the Navy, Fleischer and coworkers (1946) wrote with the permission of the Navy:

"An important ingredient of pipe covering material used on U.S. Navy vessels is amosite.... The chief reasons for the wide use of amosite felt and pipe covering in naval work are its low thermal conductivity, light weight, strength and refractoriness. When the felt and pipe covering were first developed, we were still building vessels under the Washington Treaty of Limitations in Tonnage, and every pound saved meant that much more armor, guns or ammunition for a given displacement, to say nothing of more economic operation for the weight involved in insulation.

Amosite pipe covering weighs about 14 pounds per cubic foot, with a temperature limit of 750 F, as compared to magnesia with a weight of 16 pounds per cubic foot, and a temperature limit of 500 F, High temperature amosite pipe covering weighs about 18 pounds per cubic foot as compared to 26 pounds per cubic foot for other high temperature insulations. Because of the lower conductivity and the higher temperature limit of the amosite type, less of it need be used in combination covering than other types of insulations.

The development of amosite felt started in 1934 when a need existed to secure a thermal insulation lighter in weight and thermally more efficient than the materials (blocks and cement or asbestos blankets) which were then being used on destroyer turbines. The Navy approved the type

developed by a manufacturer in September, 1934. Originally amosite was used only for turbine insulation, but it proved so satisfactory that its field of application enlarged to include insulation of valves, fittings, flanges, etc. From the initial destroyer, it has been used on almost all the destroyers built since that time and on all other combat vessels built since before the War.

Pipe covering was a later development in late 1935 and early 1936. Due to the manufacturing problems involved, it took a longer time to evolve into a satisfactory shape, and its first use on naval vessels was in 1937. Since that time its use has spread markedly and it was used on the great majority of naval combat vessels built during World War II.

Water-repellent amosite felt was developed during the early part of 1942, as a replacement for hair felt in the insulation of cold water lines to prevent sweating. Hair felt had the disadvantage of being combustible and as it was organic, when it became wet it moulded or rotted and could harbor vermin. At this time fires on board certain naval vessels convinced the Navy of the desirability of eliminating any combustible material from on board ship. Eventually water-repellent amosite was made in strips of 50 foot lengths and of suitable width to enclose the circumference of the pipe and enclosed in an extremely light-weight muslin to facilitate handling and reduce the dust, which the water-repellent agent accentuated."

17. The US Navy and the US Maritime Administration ("MARAD"; the US Maritime Commission became MARAD under the Department of Commerce in 1950 when its Government-owned shipping interests and operations transferred to this newly-established Administration) specified the types of thermal insulation and lagging for piping and machinery, as noted in the military specifications used for vessels constructed under US Navy and the Maritime Administration contracts for boilers, machinery and piping (MIL-B-18381(SHIPS) (Boilers, Steam, High Pressure Naval Propulsion) and (MIL-STD-769 (Military Standard – Thermal Insulation Requirements for Machinery and Piping)), and for steam propulsion turbines (Mil-T-17600 series (Turbines, Steam, Propulsion)) for vessels built under contract for the US Government. In accordance with these military specifications and the specific contracts that I have seen, external thermal insulation for equipment like boilers and turbines, and the associated appurtenances and piping is provided initially by the shipbuilder, and later upon maintenance or overhaul, the external insulation is provided by the activity performing the work – the Navy or shipyard/repair facility – in accordance with Navy specifications. The composition and thickness of external thermal insulation, if required by Navy specifications for a specific thermal application of a valve or fitting, are provided in the "General Specifications for Machinery of Vessels of the United States Navy" (Section S39-2; 1951; later Chapter 39 Bureau of Ships Technical Manual of 15 April 1959 and Chapter 9390 of the same Manual dated 5 Jan 1965) (BUSHIPS, 1951; 1959; 1965). The General Specification, dated 8 December 1951, specifically addresses the type and thickness of external thermal insulation (block, felt, and blanket) applied to turbines and other equipment and serves as the basic reference for ship design, building, and repairing activities. It would also be the basic reference cited in an equipment manual. Starting in the mid-to-late 1960s, the Navy specifications for the composition of thermal insulation materials changed – some asbestos-containing thermal insulation materials were no longer used, while the asbestos content of others was reduced. (Turnbull, 1969; Oic NAVSEC, Philly, 1969; COMNAVSEC, 1971; COMNAVSHIPSYSKOM, 1971; COMNAVSEC, 1972; COMNAVSEASYSKOM, 1975) During this period of time, additional Federal, as well as Navy, safety and health requirements were enacted to control the exposure to airborne asbestos fibers and meet Federal pollution control statutes.

In addition to thermal insulation, the US Navy also specified the types and styles of materials

which were used for packing and gasket applications, as well as the types and applications of electrical products used on vessels of the US Navy. The packing and gasket specifications, and their unique Navy symbols which are used to identify and order approved products for specific applications, are given in the "Standard Plan Application of Packings and Gaskets" (Bureau of Ships, Navy Department, 1945), and are discussed in Chapter 95 of the "Bureau of Ships Technical Manual (NAVSHIPS 250-000; Chapter 95; 1959). Packings and gaskets were specifically required by paragraph 95.3: "PROPRIETARY BRANDS, AVOID REFERENCE TO" and reads:

"Packing and gaskets shall be ordered by Navy symbol number or applicable specification, and not by brand name."

The use of non-friable asbestos-containing materials in gaskets, packings, wire and cable, as well as in other Navy electrical system applications where the asbestos was "embedded" and not friable, did not present an "inhalation exposure hazard" to asbestos fibers under normal conditions of handling and use. This determination was based upon data and professional opinions dating back to World War II, and re-confirmed through the work of more current investigators. (Liukonen et al., 1978; Mowat et al., 2005; Williams et al., 2007)

The Occupational Health and Safety Administration (OSHA) and the US Environmental Protection Agency (EPA) interpret the term "friable". Under OSHA, "friable" is defined as:

"C. The potential for an asbestos-containing product to release breathable fibers depends largely on its degree of friability. Friable means that the material can be crumbled with hand pressure and is therefore likely to emit fibers. The fibrous fluffy sprayed-on materials used for fireproofing, insulation, or sound proofing are considered to be friable, and they readily release airborne fibers if disturbed. Materials such as vinyl-asbestos floor tile or roofing felt are considered non-friable if intact and generally do not emit airborne fibers unless subjected to sanding, sawing and other aggressive operations. Asbestos-cement pipe or sheet can emit airborne fibers if the materials are cut or sawed, or if they are broken."

A similar definition is used by the EPA under the "National Emission Standards for Hazardous Air Pollutants" (NESHAP) regulations initially published in 1973:

"Friable asbestos-containing material (ACM), is defined by the Asbestos NESHAP, as any material containing more than one percent (1%) asbestos as determined using the method specified in Appendix A, Subpart F, 40 CFR Part 763, Section 1, Polarized Light Microscopy (PLM), that, when dry, can be crumbled, pulverized or reduced to powder by hand pressure." (Sec. 61.141) [EMPHASIS ADDED]

When the health standard for asbestos enacted under the Occupational Safety and Health Act of 1970 was published separately as the "Asbestos Standard" in 1972, the requirements for labeling or a warning notification did not apply to all asbestos-containing products – it excluded non-friable asbestos-containing materials such as these (DoL, 1972):

"(2) Caution labels--(i) Labeling. Caution labels shall be affixed to all raw materials, mixtures, scrap, waste, debris, and other products containing asbestos fibers, or to their containers, except that no label is required where asbestos fibers have been modified by a bonding agent, coating, binder, or other materials so that during any reasonably foreseeable use, handling, storage, disposal, processing, or transportation, no airborne

asbestos concentrations of asbestos fibers in excess of the exposure limits prescribed in paragraph (b) of this section will be released.
[EMPHASIS ADDED]

Section (b) of this 1972 Standard reads:

**"(b) Permissible exposure to airborne concentrations of asbestos fibers--
(1) Standard effective July 7, 1972. The 8-hour time-weighted average
airborne concentrations of asbestos fibers to which any employee may be
exposed shall not exceed five fibers, longer than 5 micrometers, per cubic
centimeter of air, as determined by the method prescribed in paragraph (e)
of this section."** [EMPHASIS ADDED]

As defined under OSHA and the EPA, it is not the mere presence of asbestos in a material – it is the so-called "asbestos-containing material" or "ACM" which is regulated by the material's asbestos content (greater than 1%) and potential to release airborne asbestos fibers (greater than 5 microns in length) in excess of the asbestos PEL. The representation and claim that an individual was "exposed to asbestos" based solely upon a material's composition is non-sensical in terms of scientific or probabilistic reality – and under reasonable thinking.

18. The United States Navy recognized that the inhalation of asbestos fibers in sufficient amounts (dose = concentration x time) could result in pulmonary disease since at least the early 1920s and had an active program to identify hazardous exposures and to prevent exposures leading to recognized health effects. In the "Instructions to Medical Officers (Notes on Preventive Medicine for Medical Officers, United States Navy)", asbestos was listed as one of the many inorganic and organic dusts that could cause pulmonary disease. (Dublin, 1922) Dublin also recognized several methods to prevent the inhalation of these dusts including: the use of water to control the release of dust; the use of local exhaust systems to remove the dust at the point of origin; the use of inclosing (sic) chambers; and the use of respirators and helmets. He stated: ***"No one of these can apply to all conditions, but the particular method to be used must be adapted to the peculiarities of the process."*** From the extensive list of inorganic, as well as organic, dusts and ***"occupations which offer such exposure"***, it is obvious that his perception of dust control was based upon the avoidance of recognizable disease, and not the mere presence of a given, or visible, amount of dust being generated.

19. The United States Navy expanded the scope of its asbestos hazard control program by including the enlisted corpsmen of the medical department in the hazard control process. In the "Handbook of the Hospital Corps" (United States Navy, 1939), the Bureau of Medicine and Surgery discussed the organization used for disease and injury prevention in the United States Navy, and took a lead position in the prevention of industrial diseases:

"The government having passed such laws must therefore lead the way in protecting its own employees.... An organization has been set up in the Navy to protect its personnel, both civilian and naval, a safety engineer is provided, who acts directly under the Assistant Secretary of the Navy. He has supervision of the safety precautions taken to protect the civilian employees in the navy yards, ammunition depots, torpedo stations, and the like. He is also a consultant in all matters pertaining to safety aboard ships, at training stations and other Navy Department activities. A naval medical officer is assigned to his office for the purpose of consultation in all matters pertaining to health and safety and to cooperate in devising means by which health may be protected and accidents prevented. Aside from this particular medical officer, all medical officers, dental officers, members of the Hospital Corps and nurses form the balance of the medical staff of this organization. It is essential that each of these

members know and understand the hazards to be encountered in the Navy, the steps to be taken to protect against injury and disease, the treatment of diseases and injuries arising therefrom and the organization of medical personnel for such purposes. Naval medical personnel are required to perform duties ashore, at sea, in foreign countries, in the air and under the sea. In each of these places a variety of health hazards exist. It is therefore necessary that these personnel have a thorough knowledge of the industry to which they are attached, the hazards presented, the methods of prevention and the treatment of all injuries occurring.

In all navy yards, the Commandant is the head of the organization. He is responsible to the Navy Department for the protection of the employees, as well as the naval personnel, under his command. He is familiar with the nature of the work being performed by the employees at his station and on the health and accident hazards presented. Accordingly, he appoints, as the working head of the organization, a safety officer or a safety engineer, as he is better known. The safety engineer must be of sufficient rank to have become familiar with the various trades in a navy yard, a knowledge of machinery, a man of cooperative ability and well liked, and having sufficient knowledge of safety devices and appliances to intelligently make inspections and recommend proper protective measures. His duties are primarily, to prevent accidents and promote healthy working conditions. It is his duty to inspect all working places, make a general survey of all mechanical conditions and to recommend the addition of all necessary safety appliances for the protection of the workers.

The Commandant further assigns a medical officer to act as advisor to the safety engineer. The medical officer must be of the same qualifications as the safety engineer, with the addition that he must be thoroughly versed in the diseases connected with Industry... It is well for members of the Hospital Corps to understand the nature of these duties in order that they may be of assistance to him in the performance of these duties: ... He acts as consultant to the safety engineer in all matters pertaining to the general welfare and health of the employees. Hygiene and sanitation are his important duties. He must interest himself in the employees and instruct them in the everyday principles of personal hygiene and self preservation. He must instruct the employees in safety measures and encourage them to cooperate in protective measures. They must be made "safety conscious" or "safety minded". The morale must be kept up....

The medical officer must inspect all working places in order to have a better understanding as to the actual conditions under which the men work. He must make appropriate recommendations to improve deficiencies noted and must then see that these recommendations are carried out."

The text further notes that the safety engineer is assisted by other personnel:

"The safety engineer is assisted in his work by the foremen of the shops and in some instances by safety committees in each shop elected by the employees. These men or committees are generally chosen from among the older employees and from men who have considerable experience in their trade... The organization of the medical advisor is composed of junior medical officers, dental officers, to some extent, members of the Hospital Corps, and of nurses. The duties of the hospital corpsmen are to assist the

medical officer in his inspections, assist in the treatment of the injured and to prepare the necessary reports and returns in cases of accident, occupational disease, and the physical examination of employees."

A similar organization is described for ***"... a battleship or in other places."***

To this end, the enlisted Hospital Corpsmen were informed of the hazards presented by asbestos and instructed to ***"... locate these hazards and afford protection accordingly."*** Two of the hazards that the Hospital Corpsmen were specifically instructed to evaluate in a questionnaire (inspection or survey form) were:

"What precautions are exercised to prevent damage from pipe covering compounds?"

"What asbestos hazards exist?"

Also, the Hospital Corpsman was instructed to help keep the workforce healthy:

"Proper working places must be provided and maintained. Hygienic and sanitary conditions must be kept on a high plane. All moving parts of machinery must be guarded, goggles provided for workers required to use them; helmets and masks for sand blasters; proper ventilation for the chrome workers; masks for asbestos workers; protection for workers in x-ray and radium; protective gloves, shoes, and other garments for foundry workers, and other means of protection too numerous to mention here must be available and used. Special physical examinations must be made of all sand blasters, asbestos handlers, those exposed to radium and its compounds, lead workers, those engaged in dusty or smoky trades, handlers of T.N.T. and other explosives, etc., to prevent the occurrence of the diseases associated with those trades from injuring the men."

20. This type of active assessment, evaluation, and recommendation for control was embraced by senior United States Navy officers. In his memorandum to the Manager of the Navy Yard, Boston, Captain HE Jenkins, MC, USN (Jenkins, 1939) discussed his findings and recommendations from his survey of the pipe covering shop and work shack at that yard. Although he stated that the health hazards to personnel were very remote, based upon his evaluation of the amount of dust released, Captain Jenkins recommended that a dust respirator and gloves be worn to supplement the ***"conscientiously and intelligently enforced"*** practice of wetting down insulating material. Captain Jenkins also addressed the impractical use of respirators during shipboard lagging operations and recommended sufficient wetting to prevent dust generation as far as practicable. Less than one week later, CDR CD Headlee, USN (1939), issued a "Production Division Notice (Number 996)" implementing these recommendations. Captain EW Brown, MC, USN (1941), in the "Annual Report of the Surgeon General, US Navy to the Secretary of the Navy" and in the scientific publication of his presentation made to the Fifth Annual Meeting of the Air Hygiene Foundation of America (1941), discussed the findings of his medical survey at the New York Navy Yard. Captain Brown, recognized as the founder of the Navy's formal occupational health program, assessed asbestos exposure and medical findings of eleven workers at the New York yard. With knowledge of occupational exposure to silica and its delayed clinical findings, and under the conditions that he observed, Captain Brown found no indication of pulmonary disease in these workers at that time. He noted that wet methods and local exhaust ventilation were implemented, and that the workers wore a respirator ***"during the dustiest aspect of the process."*** He stated that similar findings were reported in two other yards and recommended that the study be extended to all men in this trade. These references further demonstrate that senior Navy personnel actively monitored and controlled the Navy policy regarding disease and injury prevention, and were indeed the leaders in field assessment and control of occupational health hazards, including asbestos.

21. When quantitative assessment (counting) of asbestos particles in air was available, the Navy followed the recommendations of the United States Public Health Service. Based upon the findings of Dreessen and coworkers' (1938) study of asbestosis in the textile industry prepared by direction of the United States Surgeon General, the United States Navy accepted an exposure level of 5 million particles per cubic foot (5 MPPCF) as the time-weighted average (TWA) for occupational exposure. Dreessen and coworkers concluded:

"It would seem that if the dust concentration in asbestos factories was kept below 5 million particles (the engineering section of this report has shown how this may be accomplished), new cases of asbestosis would probably not appear."

This TWA is the average airborne concentration of asbestos particles to which an individual could be exposed in an eight hour period. Shorter periods of higher concentrations were acceptable as long as the average exposure calculated over eight hours did not exceed the TWA.

22. As Navy Medical Department personnel, when Captains Jenkins and Brown encountered asbestos exposure conditions that were not fully satisfactory and required changes, they made recommendations for correction of the exposure conditions to higher line (command) authorities. In both of these instances, only a qualitative assessment was made and actual exposure levels were not determined. Captain Brown (1941) performed a further medical assessment and found no significant clinical findings in the limited number of workers observed during the relatively short, post-exposure period. The Navy's occupational health program was based upon internal support for the identification and control of occupational health hazards. In order to develop a sufficient cadre of physicians and scientists, the Navy developed training programs with Columbia University's DeLamar Institute of Public Health and the Harvard School of Public Health. By the end of World War II, over one hundred physicians, scientists, and engineers had been trained in occupational health at these two leading institutions of US public health.

23. In 1936, the United States Congress recognized that it was in the national interest to build and maintain a strong merchant marine fleet and passed the Merchant Marine Act in 1936 (US Congress, 1936) in order:

"To further the development and maintenance of an adequate and well-balanced American merchant marine, to promote the commerce of the United States, to aid in the national defense..."

To this end, Title 1: Declaration of Policy; Section 101 of this Act establishes the policy of the US Government in maritime matters:

"It is necessary for the national defense and development of its foreign and domestic commerce that the United States shall have a merchant marine (a) sufficient to carry its domestic water-borne commerce and a substantial portion of the water-borne export and import foreign commerce of the United States and to provide shipping service on all routes essential for maintaining the flow of such domestic and foreign water-borne commerce at all times

(b) capable of serving as a naval and military auxiliary in time of war or national emergency,

(c) owned and operated under the United States flag by citizens of the United States insofar as may be practicable, and

(d) composed of the best-equipped, safest, and most suitable types of vessels, constructed in the United States and manned with a trained and efficient citizen personnel. It is hereby declared to be the policy of the United States to foster the development and encourage the maintenance of such a merchant marine." [EMPHASIS ADDED]

24. The "Minimum Requirements for Safety and Health in Contract Shipyards" ("Minimum Requirements") were drafted in 1942 by representatives from labor management committees, labor unions, management of private shipyards, insurance companies, the United States Maritime Commission, and the United States Navy. When approved by the US Navy and the US Maritime Commission in early 1943, compliance with these standards was expected in shipyards:

"Each contractor is hereby given notice that the Navy Department and the Maritime Commission will expect full and complete compliance with the minimum standards which bear the approval of the Navy Department and Maritime Commission, and each is requested to give full cooperation to the consultants on health and safety who will be charged with the coordination and supervision of the safety and health program of the two agencies."

H-13. A Guide for Prevention of Industrial Disease in Shipyards

13.1 Eight common types of disease and methods for their prevention are given in the following sections. Help in applying these methods will be given by the local Safety Department and by safety and medical consultants of the Navy Department and the Maritime Commission.

* * * * *

13.7 Asbestosis

a. Sources: In general, any job in which asbestos dust is breathed. For example:

<u>Job:</u>	<u>When Material Is:</u>
<i>Handling</i>	<i>Asbestos</i>
<i>Sawing</i>	<i>Asbestos mixtures</i>
<i>Cutting</i>	
<i>Molding</i>	
<i>Welding rod salvage</i>	

b. Job can be done safely with:

- 1. Segregation of dusty work and,***
- 2. (a) Special ventilation: hoods enclosing the working process and having linear air velocities at all openings of 100 feet per minute, or***
(b) Wearing of special respirators
- 3. Periodic medical examination"***

25. Less than six months after these "Minimum Requirements" were issued, the Secretary of the Navy (Forrestal, 1943) reaffirmed these requirements for all private shipyards having Navy contracts. Although the "Minimum Requirements" did not provide a specific occupational exposure value for asbestos, they gave general requirements for safe (healthful) shipyard operations. The Navy's occupational health team was responsible for assisting in interpreting the standards for implementation at Navy and contract yards throughout the country. Any significant inspection findings, whether favorable or adverse, were to be discussed first with the shipyard management, thus allowing management the opportunity to take corrective action for imminent dangers. The actual written report was to be submitted in draft form to the regional director of the Maritime Commission for final typing. Until the enactment of OSHA, these early nationally recognized safety and health standards initiated under the "Minimum Requirements" continued in effect at private US shipyards through the updated requirements of the Walsh-Healey Public Contracts Act (US Cong, 1936) and the "Safety and Health Regulations for Ship Repairing" (DoL, 1960).

26. In addressing exposure to asbestos, Philip Drinker, then Chief Health Consultant for the United

States Maritime Commission, and Professor in the Harvard School of Public Health program that was training the Navy physicians, scientists, and engineers, recommended an occupational exposure level of 5 MPPCF (Drinker, 1944). This is the same value as recommended by Dreessen and coworkers of the US Public Health Service (1938) to prevent the development of disease. The shared and jointly-held knowledge among various Federal Departments and Agencies regarding asbestos health hazards, as well as the need and methods to control these hazards were well-established.

27. In January, 1945, Philip Drinker (1945) informed Captain TJ Carter, MC, USN, Bureau of Medicine and Surgery, of a potentially serious health risk from asbestos dust exposure at the Bath Iron Works. He was concerned that similar risks might be found in other yards where the same type of pipe covering was used. In this letter, Professor Drinker stated that the manufacturers of the asbestos insulation materials used at Bath would:

"... be glad to get out a brief statement of precautions which should be taken in light of their own experience and that they would inform their competitors that I had asked them to do so. I understand that neither the Navy nor Maritime wants any change in the specifications as the performance with the present materials is entirely satisfactory. From a health standpoint we do not believe any specification changes are needed."

Drinker recommended that a study be performed to evaluate asbestos exposure and disease among workers, and stated that ***"Admiral Mills agreed that such studies would be wise before Navy or Maritime accepted this asbestosis risk as being significant in our general ship construction program."*** Four shipyards in the Northeast, two contract yards (New York Shipbuilding in Camden, NJ and Bethlehem Steel Fore River in Quincy, MA) and two US Navy yards (Boston NSY and Brooklyn NSY), were selected for this study of exposure levels and health status; additional dust exposure data were provided by the Portsmouth Naval Shipyard. The study, conducted by Fleischer, Viles, Gade, and Drinker--also called the "Fleischer-Drinker study" -- was promptly undertaken and reported in September, 1945 (Fleischer et al., 1946). The results of this study reaffirmed the Navy's position on adherence to an occupational exposure level of 5 MPPCF. The conclusions were:

"1. The character of asbestos pipe covering on board naval vessels is such that conclusions drawn from other asbestos industries such as textiles, cannot be applied."

2. The operations of band saw cutting, grinding, cement mixing, and installation aboard ship should be equipped with exhaust ventilation to keep the total dust concentration low."

3. The incidence of asbestosis among pipe coverers in the shipyards studied was low, 0.29 per cent or 3 cases out of 1074."

4. Since each of the 3 cases of asbestosis had worked at asbestos pipe covering in shipyards for more than 20 years, it may be concluded that such pipe covering is not a dangerous trade."

The results of this well-designed study, measuring actual asbestos exposure values and performing health assessments on the exposed workers, became established as Navy policy. The Navy adopted a recommended "maximum allowable concentration (M.A.C.)" value for asbestos of 5 MPPCF. This was the same value discussed by Dreessen and coworkers (1938) when assessing the asbestos textile industry with much longer daily exposure periods and primarily the chrysotile type of asbestos. It is also the value recommended by the National Conference of Governmental Industrial Hygienists in 1942, and later adopted by the American Conference of

Governmental Industrial Hygienists (ACGIH) in 1946. Among the members of the ACGIH in 1946, a private professional organization which did not offer membership to individuals affiliated with industry, were three representatives of the Navy Department and forty-two representatives from the United States Public Health Service. At this point in time, Professor Drinker was an associate member of the ACGIH representing one of the educational institutions – Harvard University. Since there were no federal, state, or local occupational exposure standards, the Navy used the occupational exposure level that the best scientific and medical evidence supported. In 1955, the Navy adopted the "Threshold limit values for toxic materials" developed by the American Conference of Governmental Industrial Hygienists as a basic reference and **"to provide guidance toward the reduction of potential health hazards encountered in the industrial environment for both military and naval civilian personnel."** The Navy (BUMED, 1955) recognized that:

"[The] threshold limit values should be used as a guide in the control of health hazards and should not be regarded as fine lines between safe and dangerous combinations. The most desirable levels in all cases are those approaching zero, but practical considerations frequently require the acceptance of higher levels which are safe, but not ideal."

Moreover, the Navy recognized that:

"[The] threshold limit values ...are based on the best available toxicological information, long-term industrial experience, and experimental studies. In as much as these values are constantly being reevaluated, revisions or additional will be made as further information becomes available."

28. The "Bureau of Ships Technical Manual, Chapter 51: Boilers (BuSHIPS, 1955)" addresses the engineering and operating aspects of boilers and establishes Navy policy in these areas. Although this official publication does not address all medical aspects of the Navy's occupational health program, in Section 51-43, it specifically states precautions for work inside the furnace of a steam generator under "Examination and Cleaning of Firesides":

"The use of a respiratory mask for toxic dust during cleaning operations is required to prevent any toxic effect of the dust on personnel."

This brief note of requirement did not discuss the various components of the toxic dust – nor all aspects of the Navy's occupational health program discussed above. From the industrial hygiene perspective at the time, the primary dusts of concern in the furnace of a Naval steam generator were crystalline free silica and carbon/carboniferous residue from the incomplete combustion of fuel; other less significant particulates included metallic oxides, asbestos, and asbestos decomposition products. The requirements for a Navy gas-free engineer to assess and authorize controlled entry with appropriate safety equipment into a closed space, such as tanks, voids, and "cold" boilers, is contained in The "United States Navy Safety Precautions, OPNAV 34P1" (CNO, 1953).

29. The Commander, Long Beach Naval Shipyard, and his management, production, and medical staffs, including the Industrial Hygiene Department, were exemplary in controlling occupational exposures through direct involvement and coordination with civilian shipyard workers, organized labor officials, and the Commanding Officers and crews onboard ships undergoing maintenance and repair. In May 1947, CAPT TP Wynkoop, USN, the Shipyard Commander, wrote an open memorandum for "Commanding Officers of Ships" regarding "Safety practices of fleet personnel at this Shipyard" (Wynkoop, 1947). This Memorandum was later published in the Navy-wide publication: "Safety Review" in July, 1947, and states:

"In accordance with instructions, issued by the Bureau of Ships and the Office of Industrial Relations in the Secretary's Office, it is requested that

commanding officers of ships in the shipyard take steps to insure that military personnel aboard their ships conform to Shipyard safety practices when performing work within the Shipyard. The Safety of naval personnel is no less important than that of civilian personnel.”

To this end, CAPT Wynkoop established a liaison between each ship's force via an appointed safety officer and the Yard Safety personnel; provided for a visit by a Yard Safety inspector upon arrival in the Yard to deliver and discuss pertinent safety orders; provided for additional consultation and advice via the Yard's Safety Superintendent; and made the loan of safety equipment, including respiratory protection, available to ships. He additionally wrote:

“Commanding officers are urged to make full use of available safety equipment and technical advice in performing ships force work to the end that accidents to naval personnel may be minimized, if not eliminated within the shipyard.”

The level of occupational safety and health leadership and involvement demonstrated by this Shipyard continued with many highpoints. Mr. OW Meeker (Master, Shop 56, Long Beach Naval Shipyard) told the assembled representatives of the major Navy shipbuilding and repair facilities at the First Shop 56 Masters' Conference of Pipe and Copper Shop Master Mechanics' Conference held at the Boston Naval Shipyard in May, 1957 (Meeker, 1957), that he, even as a non-medical professional, recognized the potential hazard of prolonged inhalation of significant concentrations of airborne asbestos fibers:

“The most apparent symptom of asbestosis is lethargy or a lack of vitality. What we suspect to be lead in the posterior might well be asbestos in the lungs.

... Remove the cause by substituting other products such as Armaflex and StaFoam for asbestos whenever possible. However, this will take some doing.

In the meantime, the answer is wearing of respirators by all who handle asbestos products. To many the very idea of wearing respirator (sic) is repugnant. However, a respirator on the face is preferable to asbestos in the lungs. Therefore, gentlemen, ours definitely is the important and difficult task of providing and installing effective insulating materials aboard Naval Vessels. Moreover, this task must be accomplished without sacrificing our workmen in the process.”

A Navy study of pipecoverers performed by the Industrial Hygienist at this same shipyard and reported in January, 1959 (Anon, 1959), concluded:

“The work habits, personnel protection and working environment of these men are not of desirable standards. These conditions, plus their increasing years of exposure and the medical study, indicates the need for corrective action.”

In order to achieve compliance with existing Navy occupational health policy, the Secretary for the Asbestos Union at Long Beach Naval Shipyard (Local #20), Mr. Webster Ay, was kept involved with asbestos program developments throughout this period of time. In an April 1957, letter from the Yard Industrial Hygienist, Mr. JR Sheehan, Mr. Ay was informed about medical developments to maintain and improve the health of workers in the “dusty trades”, and his cooperation was sought (Sheehan, 1957). The use of ventilation and respiratory protection was encouraged for his members. As a demonstration of this cooperation between management and

workers, Mr. Ay co-developed the nationally-circulated "Grim Reaper" poster with Mr. CV Krieger, the Shipyard Safety Superintendent (Sickles, 1961):

**"Is your FUTURE...With Him (the Grim Reaper) ... Or Them (your Family)?
WEAR YOUR RESPIRATOR"**

Later, the civilian Navy industrial hygienist at Long Beach Naval Shipyard, Mr. WT Marr, further wrote on the hazards of, and controls for, asbestos insulation work by shipyard insulators onboard ships. (Robbins and Marr, 1962; Marr, 1964) This cooperation between management and labor in promoting worker safety and health reflects the level of involvement between the unionized asbestos workers (Association of Heat and Frost Insulators and Asbestos Workers) who were affiliates of the American Federation of Labor-Congress of International Organizations (AFL-CIO) and the US Government. During this period, the AFL-CIO developed a close relationship with Irving J. Selikoff, MD for the assessment and control of occupational illnesses arising from exposure to asbestos by members of this organization.

30. The recognition of the potential hazard created by exposure to significant concentrations of airborne asbestos fibers was also evident at the Boston Naval Shipyard since the late 1930s. As mentioned above, there is documentation that the senior Navy Medical Department representative at the Boston Naval Shipyard (CAPT HE Jenkins, MC, USN) performed site evaluations to assess inhalation of airborne asbestos fibers as far back as 1939. (Jenkins, 1939) Captain Jenkins noted the use of the **"conscientiously and intelligently enforced"** practice of wetting down insulating material in the production shop. He recommended that this practice be extended to shipboard operations in order to prevent dust generation as far as practicable as the use of respirators was impractical in such settings. The shipyard management agreed and promptly issued a Production Notice which made these medical recommendations mandatory. (Headlee, 1939) As noted above, the Boston Naval Shipyard was one of the two Navy yards surveyed in the Fleischer-Drinker Study published in 1946. The results of this study supported the Navy's program for asbestos control which was aimed at controlling release of asbestos fibers to levels below which were deemed to be hazardous – that is, below 5 MPPCF. The Boston yard continued its contributing role to the Navy's asbestos control program by hosting the "Pipe and Copper Shop Master Mechanics' Conference" at the Boston Naval Shipyard in 1957. Mr. George P. Chamberlain, Master Pipefitter and Coppersmith (Shop 56) at the Boston Yard, served as the Conference Chairman. In his "Travel Report" submitted by Mr. EB Stecher from the Navy Bureau of Ships (Stecher, 1957), Mr. Stecher reflected upon some of the comments made by Meeker, but he felt that compelling workers to wear respirators had been unsuccessful in the past, and that material substitution was the only method which offered complete resolution of the health hazard from asbestos:

"Considerable discussion took place regarding asbestosis (silicosis). This is still an acute problem in many of our Yards. It was pointed out that regardless of the instructions, the insulation men will not wear masks especially when installing insulation aboard ships. The only solution appears to be to find an insulation that is not a health hazard."

However, in his statement regarding his idea for resolution of the asbestos inhalation hazard, Mr. Stecher failed to consider the obvious necessity of dealing with the problem at hand – namely, the asbestos-containing materials which were used extensively onboard Navy ships of the era and work which needed to be currently accomplished while providing adequate protection for workers. Meeker also sought suitable replacement materials, but made that consideration when he said:

"In the meantime, the answer is wearing of respirators by all who handle asbestos products. To many the very idea of wearing respirator (sic) is repugnant. However, a respirator on the face is preferable to asbestos in the lungs."

Mr. Ernani Storlazzi, CIH (Retired) in his Declaration dated October 8, 2008, testified that he was initially assigned to the Boston Yard as an active duty Navy officer and that he then continued as a civil service industrial hygienist from 1946 until the Boston Naval Shipyard closed in 1974. During that period dating back to the mid-1940s, he states that information regarding the potential hazards of asbestos and the proper means of control were available to workers in the Boston yard:

"During my entire tenure at the Boston Naval Shipyard, I was mindful of potential asbestos dust hazards. The standard operating practice at the Boston Naval Shipyard was to survey various shops and ships under repair, including the pipecovering shop, on an intermittent basis. Whenever such surveys revealed potential hazards, the workers and/or their superiors would be advised as to appropriate precautions to take. This included routinely instructing the workers in the pipecovering shop that they should take precautions regarding heavy asbestos dust exposures. This included instructing the workers to utilize respirators, to implement local exhaust procedures and/or to use wet down techniques. In short, the state of the art precautions of the time were communicated to the workers and management in the Boston Naval Shipyard."

He further adds that such information and programs were widely disseminated throughout the US Naval establishment:

"From my own observations at the Boston Naval Shipyard and from information regarding other shipyards across the country, knowledge regarding the potential hazards of asbestos exposure were well-known throughout the shipyard work force. Undoubtedly, anyone engaged as a pipecoverer should have been well aware of such information, and tradesmen in other occupations had every opportunity to gain similar knowledge. Starting in the earliest years, some of the workers were utilizing respirators. Additionally, starting in the earliest years, some operations would be segregated and marked off to keep uninvolved workers away from the potential exposures. By the late 1960s, the vast majority of insulation workers were utilizing dust masks on at least a part time basis. Information regarding asbestos hazards was readily available to anyone in the shipyards. Additionally, over the years, this information had been communicated throughout the Naval community at various levels. I have no doubt that many, many officers and men in the United States Navy were fully informed regarding asbestos dust hazards from the earliest 1940s to all times thereafter."

"During my entire time with the Navy, both as a uniformed officer and subsequently as a civilian employee, I believe that I was well informed and well educated regarding my professional field of industrial hygiene. At all times, I felt that I was properly informed regarding the state of the art pertaining to asbestos dust and its potential hazards. Likewise, I believe my colleagues in the Navy, across the country, were similarly well informed."

Mr. Storlazzi's Declaration is supported by the Memorandum from Mr. GP Chamberlain dated 1 October 1962. Mr. Chamberlain (the Pipe and Copper Shop Conference Chairman in 1957, noted previously) states that the purpose of this Memorandum addressing "Respiratory Protection for Pipecoverers" is:

"To disseminate instructions concerning the safety requirements which are mandatory for all personnel working with asbestos insulating material."

Mr. Chamberlain notes that asbestos dust counts were obtained during routine practices in the shop and onboard ships during the period of May to June, 1962. The results of these surveys prompted him to re-direct pipecoverer supervisors to again emphasize asbestos control procedures and ensure specified types of respiratory protection for dusts were assigned to pipecoverers onboard ship and that they were worn when asbestos-containing materials were being handled and a hazardous level of respirable dust was generated. He further directs that:

- "e. Care shall be exercised to control the formation of dust at all times. Old insulation material shall be placed in suitable containers as it is removed and not dropped or left lying on the ... [ILLEGIBLE] ... shall be removed to a weather deck promptly.***
- f. Following insulation removal work, the deck shall be cleaned of all accumulated dust to prevent further contamination of the work area.***
- g. Where a large quantity of asbestos insulation is to be removed within a confined space, arrangements shall be made to assure that adequate exhaust ventilation is provided...***
- 4. Compliance with the safety requirements herein described is mandatory on the part of all personnel concerned."***

Mr. Meeker, Mr. Chamberlain, and Mr. Storlazzi each realized that constant oversight and periodic reemphasizing of the asbestos handling and control requirements were essential when the potential for a hazardous level of respirable asbestos dust was present under shipyard working conditions. Finally, in 1969, the Navy determined that the only practical method of controlling exposure to hazardous levels of asbestos dust throughout the Navy was to make a concerted and directed effort to use substitute thermal insulation products manufactured either without asbestos, or using insulation materials with a lower content of asbestos and noted:

"Since individual habits of workman play a large role in their exposure patterns, observations of their practices have been included in this survey. Most insulation workers are aware that exposure to asbestos dust, even in low concentrations, is hazardous but they also feel that the hazards are unavoidable and must be accepted as part of the occupation. Moreover, a recently published survey conducted by a naval shipyard aboard selected ships has revealed that, although dust respirators have been required during installation and ripout of asbestos, 76% of the workers did not use them. In fact 50% did not possess respirators even though they were readily available in central tool rooms. This lack of worker discipline and the seriousness of the lung effects of asbestos could be the main deciding factors for considering the elimination of asbestos as a lagging material and as a cement on piping, ducts, and boilers and thus reduce and eradicate the reported incidence of asbestosis ranging from up to 21% among shipyard insulation workers."

31. An early example of the many safety handbooks issued by the Navy as aids in safety indoctrination and accident prevention is the Bureau of Ordnance's "Safety Handbook for Pipefitters" issued on January 7, 1958. This handbook provides, in part:

"Asbestos. Asbestos dust is injurious if inhaled. Wear an approved dust respirator for protection against this hazard."

32. In 1959, the Navy, the Coast Guard, the Maritime Administration, and maritime industrial employers, as well as trade associations and labor organizations, were involved in the development of the standards which led to the "Safety and Health Regulations for Ship Repairing" (DoL, 1960). These Regulation were mandatory for all maritime repair and construction activities:

“... safety and health regulations that have been determined by the Secretary of Labor to be reasonably necessary to protect the life, health and safety of employees engaged in longshoring, ship repairing, and related employments covered by Section 41 of the Longshoremen's and Harbor Workers' Compensation Act, as amended.

...

These regulations are mandatory with respect to employers subject to the Act, and affected persons should familiarize themselves with the contents of this publication. In this connection, Bureau personnel concerned with the administration of these regulations will extend all possible assistance.”

In these regulations, the Department of Labor (DoL) also adopted the occupational exposure level of 5 MPPCF for asbestos and required the use of respiratory protection at private longshoring, ship repairing, and related employments when indicated:

***“Protection against particulate contaminants not immediately dangerous to life.
(1) When employees are exposed to unsafe concentrations of particulate contaminants, such as dusts and fumes, mists and fogs or combinations of liquids, they shall be protected by either and air line or filter respirators, except as otherwise provided in regulations of this part.”***

For comparison to the degree of risk and hazard, the Department of Labor also used the occupational exposure level of 5 MPPCF as the same absolute value for high “free” crystalline silica dust (greater than 50% free silica). The silica value is also the same value established by the ACGIH in 1942 and promulgated in 1946. These nationally-enforced regulations, as well as the requirements of the Walsh-Healey Public Contracts Act, were applicable to private (non-government owned) shipyards.

33. The use of the 5 MPPCF level as the occupational exposure value continued to be generally accepted by professionals practicing occupational health in the United States. This occupational exposure value, and the widespread use of asbestos, continued in the Navy until the late 1960s when the scientific and medical communities (Selikoff 1965, 1967) and the United States Navy (Turnbull, 1969; Oic NAVSEC, Philly, 1969; COMNAVSEC, 1971; COMNAVSHIPSYSKOM, 1971; COMNAVSEC, 1972; COMNAVSEASYSKOM, 1975) had evidence that it was not sufficient to adequately control the health effects of exposure. This level was then changed, by the fledgling Occupational Safety and Health Administration (OSHA), to a time-weighted average of 12 fibers per cubic centimeter (12 f/cc) in May, 1971 and then to an Emergency Temporary Standard (ETS) of 5 f/cc in December, 1971. On June 7, 1972, the Federal asbestos regulations “Part 1910—OCCUPATIONAL SAFETY AND HEALTH STANDARDS: Standard for Exposure to Asbestos Dust” was published permanently reducing the permissible exposure limit of a time-weighted average to 5 f/cc. The new Federal standard also contained an extensive asbestos control program which was required of all employers. This “OSHA Asbestos Standard” which was quite similar to the Navy instruction released by the Navy the previous year (February, 1971): “NAVSHIPSINST 5100.26: Control of Asbestos Exposure Hazards” (DoN, 1971).

34. The Navy's sophistication regarding asbestos hazards in the 1960s was thus at the cutting edge of then existing science and medicine. Captain NE Rosenwinkel, MC, USN, representing the Navy's Surgeon General and the Bureau of Medicine and Surgery, provided information regarding the Navy's knowledge of asbestos hazards to shipyard employees for inclusion in a statement issued by Rear Admiral JJ Stilwell, USN, of the Shipyard Management Directorate, Naval Sea Systems Command in 1968 (Rosenwinkel, 1968):

“The United States Navy is well aware of the hazards of asbestos to its employees engaged in ship construction and ship repair at naval shipyards. Hazard control measures implemented by the shipyard medical departments and safety divisions are in accordance with accepted standards of industrial hygiene practices in the United States. Stringent

efforts are directed at keeping the concentration of airborne asbestos dust below the level recommended by the American Conference of Governmental Industrial Hygienists. An energetic periodic physical examination program insures the health of personnel exposed to this hazard."

35. During the late 1960s, the state-of-the-art regarding the known health hazards of asbestos changed both inside and outside the Navy – as well as other US Government Departments and Agencies and private employers. Procedures to control asbestos exposures were made more stringent as the accepted – and now legally enforced – occupational exposure levels were reduced. Insulation manufacturers started including precautionary statements on their packaging in the early to mid-1960s. Asbestos exposure and control were being addressed at different levels of command throughout the Navy. The Naval Ship Engineering Center was searching for substitutes for thermal insulation products which could meet the rigorous engineering requirements for shipboard applications: ***"Letter inquiries addressed to the Naval Shipyards resulted in 100% responses, whereas those addressed to private shipyards failed to elicit replies from Newport News Shipbuilding and Drydock Co. and Ingalls Shipbuilding Corp. However, General Dynamics, Lockheed Shipbuilding and Bath Iron Works responded to our inquiry."*** (COMNAVSEC, 1969). A meeting between senior engineering, safety, and medical personnel was held to evaluate possible methods for reducing exposure and to make recommendations to the Chief of Naval Operations. (Turnbull, 1969) Major Navy shipyards were sharing their research on asbestos exposure and control measures. (Mangold, 1970) Private contract shipyards were similarly controlling asbestos exposures and seeking suitable substitutes that were acceptable to the Navy and the Maritime Administration.

36. As mentioned, it was not until 1971 that statutory "permissible exposure limits (PELs)" became nationally established (and mandatory) under the Occupational Safety and Health Act (PL 91-596). These standards and their specific requirements applied to the employer, as the source of control of safety and health hazards in the workplace. Although these national standards applied to shipyards and other industries using asbestos, they did not directly apply to active duty Navy personnel and military unique settings. However, under a series of Executive Orders, the Navy maintained an occupational health and safety program consistent with OSHA requirements. At the time of enactment in 1971, the PEL for asbestos was initially 12 fibers per cubic centimeter (f/cc). However, based upon the evolving and current scientific and medical recommendations by the time of enactment, the Occupational Safety and Health Administration (OSHA) emergently lowered the PEL to 5 f/cc (ceiling value of 10 f/cc) in late 1971, with a permanent standard of 2 f/cc becoming effective in 1976. The 1971 OSHA "Asbestos Standard" specifically addressed labeling of asbestos-containing materials based upon friability and the potential release of asbestos fibers into the air which would exceed the permissible exposure limit:

"(2) Caution Labels.

(i) Labeling. Caution labels shall be affixed to all raw materials, mixtures, scrap, waste, debris, and other products containing asbestos fibers, or to their containers, except that no label is required where asbestos fibers have been modified by a bonding agent, coating, binder, or other material so that during any foreseeable use, handling, storage, disposal, processing, or transportation, no airborne concentrations of asbestos in excess of the exposure limits prescribed in paragraph (b) of this section will be released."(OSHA, 1971) [EMPHASIS ADDED]

As discussed previously, based upon the permissible exposure limit criteria at the time that OSHA was enacted in 1970, non-friable asbestos-containing components used for electrical and fire retardant properties in insulation applications, as well as typical gasket and packing materials, did not require labeling due to their composition and friability. Even before this period, these types of materials were not considered to present any hazard during routine use and handling (Fuller, 1945). In 1975, OSHA recognized sufficient medical and scientific evidence of human carcinogenicity

to recommend the reduction of the permissible exposure limit to 0.2 f/cc. After legal challenges, OSHA reduced the PEL to 0.2 f/cc in 1986, and further reduced it to its current value of 0.1 f/cc in 1994. Requirements from the highest levels of authority in the United States Navy established the permissible occupational exposure levels and control methods as they changed during this post-OSHA era. (DoN, 1971; BUMED, 1973; OPNAV, 1974) The Navy took further additional steps to eliminate the use of ***“asbestos in ship construction and maintenance, and to direct actions which will further reduce asbestos exposure”*** through its Asbestos Elimination/ Substitution Personnel Protection Program (COMNAVSEASYSOM, 1975).

37. The Navy has continued to follow the policy of using occupational exposure levels based upon the best available scientific and medical information (BUMED, 1955). The federal PELs, established by the Occupational Safety and Health Act of 1970, were generally based upon the American Conference of Governmental Industrial Hygienists' Threshold Limit Values (TLVs) published in 1968. Due to statutory requirements, changes to the limited number of chemical PELs have generally been slow. PELs have been changed for a relatively few chemicals since the enactment of OSHA in 1970. The TLVs are periodically reviewed and an updated list is published annually. The TLVs more closely reflect the current state of knowledge and professional practice in occupational health. The Navy continues to use the most appropriate occupational exposure levels in the assessment of exposures and follows the requirements stated in the Chief of Naval Operations Instruction “OPNAVINST 5100.23F” (CNO, 2002) to provide workplaces that reflect the state-of-the-art knowledge and technology, consistent with its defined mission:

“The maintenance of a safe and healthful workplace is a responsibility of commands throughout the Navy. A successful Navy Occupational Safety and Health (NAVOSH) program, one that truly reduces work-related risks and mishaps, results only when support and commitment to the program permeate every level of an organization. Within the Navy, the Chief of Naval Operations (CNO) has overall responsibility for the NAVOSH program and implements the program through the chain of command. Line management is responsible for the maintenance of safe and healthful working conditions.”

38. The Navy's modern safety program started in 1917 with safety engineers assigned to each naval shipyard. This initial program was expanded in 1922 with safety programs for civilian employees being introduced at all naval activities (NAVEDTRA, 1993). The Navy's Safety Program was driven from the highest level of authority and operational command – the Chief of Naval Operations (CNO). The “United States Navy Safety Precautions,” OPNAV 34P1, was signed out by the Acting Secretary of the Navy, CS Thomas, on 8 June 1953 (CNO, 1953). In his “charge” written in this instruction, Mr. Thomas states:

“The safety of its personnel and the preservation of its materials have always been a major concern of the Navy Department. Evidence of this is the provision in Article 0406 of U.S. Navy Regulations, that “Each Naval Technical Assistant shall prepare and issue to the Naval Establishment the safety precautions, and instructions pertaining thereto, which are necessary or appropriate in connection with matters under his technical direction.”

*

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“In recognition of the burden of responsibility which a commanding officer has for the personnel and material under his command, a governing article, 01104 Basic Rule of Responsibility, has been included to allow for adjustments to local conditions and unusual circumstances. The complete text of this article not only appears in Chapter 1, but is reprinted on the title page of each chapter of the book.”

The "Basic Rule of Responsibility" states:

"Safety is a command function. Responsibility for the safety of personnel is vested in the commanding officer. Because these safety precautions apply only to usual conditions, commanding officers or others in authority may find it necessary to issue special precautions to their commands to cover local conditions and unusual circumstances. In addition to the posting of appropriate precautions, careful instruction and indoctrination of all personnel are necessary to ensure effective compliance with these precautions."

The Navy's comprehensive Safety Program was in existence before the Second World War and it continues to this day through the "Safety Precautions for Shore Activities" (initially OPNAV 31P1: United States Navy Safety Precautions (CNO, 1953); later NAVSO-2455 (OCMM, 1965); now NAVMAT P-5100 series (NAVMAT, 1970)) and "Safety Precautions for Forces Afloat": OPNAVINST 5100.19 series (CNO, 1973), and the "NAVOSH (Navy Occupational Safety and Health) Program Manual": OPNAVINST 5100.23 series (initially CNO, 1983). The "Naval Ships' Technical Manual (NSTM)" chapter on thermal insulation: "Chapter 9390: Thermal Insulation" was specifically revised to stress "Safety Precautions for Asbestos" in July 1972 and address the Navy's increased vigilance in controlling asbestos exposure onboard ship. The initial Navy-wide Safety Program combined both shore and shipboard environments (CNO, 1953):

"2. Shipboard Safety. In most instances the hazards involved and the applicable precautions for a given type of work are the same whether the work is done afloat or ashore. Precautions afloat are therefore not presented separately from precautions ashore except when they concern specific shipboard activities or conditions." [EMPHASIS ADDED]

...

"Delegation of Authority. While the commanding officer cannot delegate the responsibility for the safety of personnel under his jurisdiction, he may delegate his authority to the executive officer and other subordinates to ensure that all prescribed precautions are understood and strictly enforced." [EMPAHASIS ADDED]

...

"11312 Certification of Closed Compartments

- 1. Entry into Closed or Poorly Ventilated Spaces. No person shall enter any closed compartment or poorly ventilated space in any naval unit including naval or Navy operated vessels unless and until a "gas-free" certificate has been issued by the safety engineer or his authorized representative to certify that the danger of poisoning or suffocation of personnel, or the danger of ignition or explosion of flammable gases has been eliminated or reduced to the lowest practical minimum.***
- 2. Entry in Emergencies. In case of emergency, when it is necessary to send a man into a compartment or tank not certified as being gas-free or as containing sufficient oxygen, the man shall be equipped with an air-line mask or an oxygen rescue breathing apparatus."*** [EMPHASIS ADDED]

...

" 11322 Definition of terms

- 1. Closed Compartments or Poorly Ventilated Spaces are any spaces that are not well ventilated, or which have been closed for any appreciable length of time. Unventilated storerooms, blisters, double bottoms, tanks, cofferdams, pontoons, voids, idle furnaces, cold boilers, etc., are typical."*** [EMPHASIS ADDED]

...

"Do not clean chips from the surface of machines with compressed air or with hands. A brush or hook should be used."

...

"The cleaning of one's clothes with compressed air is prohibited."

...

"Compressed Air. Compressed air shall never be blown towards anyone, used for cleaning of personal clothing, or used to cool a person off."

39. In order to coordinate sharing of occupational health information between organizationally distinct, and geographically distant, naval activities, the Bureau of Medicine and Surgery instituted the quarterly publishing of occupational health reports: "Occupational Health Hazards" during World War II. These reports were initially received by the Bureau of Medicine and Surgery from all field commands staffed with occupational health professionals, condensed, and redistributed to all the submitting commands (BUMED, 1955; 1959, 1961a, and 1961b). Later, the Navy Environmental Health Center continued this function until the late 1990s when electronic information sharing made the earlier process obsolete. These reports demonstrate that the sharing of industrial hygiene and other occupational health information and services between commands throughout the Navy was common since early in World War II.

40. Based on my education, training, and experience, it is my professional opinion that the Navy, the Maritime Commission, and other Federal Departments and Agencies were well aware of the health hazards associated with the use of asbestos from the early 1920s, consistent with the evolving state of knowledge at a given time. The Navy's extensive asbestos control program was the best in the Nation – controlling exposure to airborne asbestos fibers to a level below that known to be associated with either asbestosis or lung cancer – the only two asbestos-related pulmonary diseases known before 1960. Hueper, writing on occupational and environmental cancers in 1966, added mesothelioma to the cancers associated with clinical asbestosis, and notes the lack of long-term medical and pathological studies involving individuals exposed to asbestos dust. Although the control of asbestosis was accepted as also controlling the potential for further development of either lung cancer or mesothelioma, more data and analyses were needed at that time (Hueper, 1966).

"Since the presence of asbestosis has usually been considered the prerequisite for the subsequent development of a carcinoma of the lung or of a mesothelioma of the pleura or of the peritoneum, these deficiencies in the available information tend to impair a clear demonstration of the real scope of the existing associations between the two conditions. A second difficulty encountered in reliably assessing the extent and degree of lung cancer hazards of asbestotics is represented by the fact that there has occurred in the past a confusing duplication in reporting cases of asbestosis cancers."

The Navy's and, similarly, the US Maritime Commission's decisions to use asbestos-containing materials were based upon operating requirements and missions in light of the known health hazards at the various periods of time. The Navy had a longstanding and notable occupational safety and health program that addressed asbestos and many other health hazards, and that provided exposure control recommendations and methods that were consistent with the state-of-the-art knowledge in science and medicine. The Navy operated under the premise that control of the exposure to asbestos fibers could essentially eliminate the hazard of a material considered essential for sustained Navy operations. Using established scientific and medical knowledge, the Navy developed an active program to control the release of asbestos fibers in dusty operations, as well as, to monitor the health of workers at risk. Indeed, the very first articles associating "by-stander" exposure with asbestos were not published until 1965, and the exposure situations were different from those in the US Navy (Newhouse and Thompson, 1965a; 1965b). The landmark study of Fleischer-Drinker, reported in 1945, confirmed the general thought that exposures in the Navy to asbestos containing materials could be controlled and health effects could be limited by medical surveillance. Navy

industrial programs were directed at controlling what was considered significant releases of dust. During the period from about 1938 through the later 1960s, the widely accepted occupational exposure level was 5 MPPCF. In the mid-to-late 1960s, the Navy led the way in assessing asbestos exposure of personnel and developing a program and process to eliminate the material based upon new scientific and medical information that was becoming available.

41. To the extent that the equipment and product manufacturers with which I am familiar ever delivered equipment to the US Government for use on vessels constructed for the US Navy and the Maritime Commission/Administration, the US Government had already recognized that the prolonged inhalation of sufficient concentration of respirable asbestos fibers could result in pulmonary disease. Indeed, this knowledge was held by the US Government prior to the period of construction of ships in the 1940s (Dublin, 1922; Jenkins, 1939; Bureau of Medicine and Surgery, 1939). Based upon that scientific and medical knowledge, the US Government, generally, and the US Navy, specifically, by the early-to-mid 1940s had already developed an active and robust program to control exposure to airborne asbestos fiber concentrations at levels recognized to be harmful, and medically monitored personnel exposed to those levels. Additionally, the Navy established engineering control procedures (including isolation, exhaust ventilation, wet methods, and process changes to minimize dust release) and training, and required the use of respiratory protection for personnel considered to be at risk of excessive exposure during dusty operations (Dublin, 1922; Brown, 1941; Forrestal, 1941; Knox, 1941). These dusty operations primarily arose from the handling and use of the friable asbestos used in thermal insulation applications. Control of exposure to asbestos fibers based upon the concentration and duration – sufficient to prevent asbestosis – was considered by medical authorities, both international and domestic, to concomitantly control the (then believed) causal relationship between asbestosis and pulmonary cancers. (Smith, 1952; Doll, 1955; Hueper, 1966) Indeed, the levels discussed in the landmark studies by Merewether and Price (1930a, 1930b, 1933a, 1933b, 1934) to prevent the development of asbestosis were actually far above the occupational exposure level of 5 MPPCF used by the US Navy. Thus, by controlling the exposure of personnel to asbestos fibers and preventing the development of asbestosis, the Navy, based upon the consensus of the scientific and medical communities of the day, *de facto* controlled the potential for the development of respiratory cancers. It is further worth noting that, at this time period, the Navy and other US Government Departments and Agencies, and the scientific and medical communities in general, were **not** seeking to control the smoking of tobacco products as the significant cause of the rising lung cancer rate.

42. Under the accepted occupational exposure “guideline levels” of the time period before the enactment of OSHA (there were no national, statutory occupational exposure levels (OELs)), there was absolutely no hazard created by the handling and use of asbestos in gasket and packing applications in naval steam systems – or likewise – in non-friable, asbestos-containing electrical insulating components. The potential release of respirable asbestos fibers was, and still is, minimal from these sources (Liukonen et al, 1978), as well as in cable, wire, and other electrical applications – such as bound phenolic resins and “fish paper” insulation – based upon my own personal knowledge and professional experience, as well as the many studies cited by Mowat et al., 2005, and Williams and coworkers, 2007. Many Navy and other published studies have confirmed that the greatest potential for exposure to airborne asbestos fibers onboard ship comes from the uncontrolled application and removal of thermal insulation, not the handling of gaskets and packings, or wire, cable, and other electrical components. (Robbins and Marr, 1962; Marr, 1964; Harries, 1971; Liukonen et al, 1978; Mowat et al., 2005; Williams et al, 2007; Hollins et al, 2009) Attention to even the potential for release of asbestos fibers from non-thermal insulation materials only arose as the permissible exposure limit (PEL) for asbestos decreased dramatically following the enactment of the Occupational Safety and Health Act in 1970, and the environmental controls of the “US Environmental Protection Agency National Emission Standard for Asbestos” (US Congress, 1971) and the Toxic Substances Control Act (TOSCA) (USEPA, 1976) regulated asbestos as a controlled environmental pollutant. Prior to that period in the early to mid-1970s, the Navy and contract shipyards (and other federal and state entities) were using 5 million particles per cubic foot (5 MPPCF) as the occupational exposure level for asbestos;

environmental releases into air, water, and land were not regulated. It was not until the accepted occupational exposure levels of the post-OSHA period decreased that the possible release and exposure to asbestos fibers from the handling of gaskets and packings at concentrations approaching the new OEL became a concern. Prior to the 1990s, the Navy study by Liukonen and coworkers (1978) at the Puget Sound Naval Shipyard (PSNSY) stands out as one of the few, and best known, evaluations of such materials. This study demonstrated that gaskets did not present an asbestos hazard under normal conditions to individuals who were directly working with such materials.

43. Similarly, Captain JC McArthur, USN, addressing a Congressional subcommittee on behalf of the Navy, noted in 1978 (McArthur, 1978):

"In addition to thermal insulation, other shipboard asbestos applications include those products which can be found in general use by industry and in homes and office buildings. Floor tiles, various gaskets and valve stem packings and galley range insulation are just a few examples. However, this asbestos is in a bonded or contained form and routine careful handling would preclude emissions of potentially hazardous levels of airborne fibers."

Again, at the time that this official statement was made by CAPT McArthur in 1978, the permissible exposure limit (PEL) of 2 fibers per cubic centimeter had been established under the Occupational Safety and Health Act of 1970 (US Congress, 1970). This level was also used by the United States Navy at that time. This level of 2 f/cc was significantly lower than the OEL used by the US Navy during the period from the 1940s through the late 1960s – 5 million particles per cubic foot (5 MPPCF; approximately 30 f/cc).

44. An earlier study performed at the same Puget Sound Naval Shipyard (Mangold et al, 1970) evaluated asbestos controls and the prevalence of clinical findings associated with uncontrolled exposure to airborne asbestos fibers. It must be emphasized that Mangold's study was conducted among a population of shipyard workers who had their total period of employment before the strictly-mandated exposure controls and permissible exposure limits were established under the Occupational Safety and Health Act of 1970. Furthermore, personnel listed under the various trades were included in the study based upon their current working position – not their past occupational history; this is an important confounder. These federal employees ("civil servants") were shipyard craftsmen who worked daily in specific trades building, repairing, overhauling, and modernizing Navy ships – their tasks and duties were not equivalent to those of the Sailors who primarily operated and maintained that shipboard equipment at sea-but rather, their shipyard duties represented the extreme in an exposure analysis. Mangold's study identified 22 of 104 pipecoverers (21.2%) with "positive chest x-rays" which were suggestive of prolonged asbestos exposure, whereas only 6 of 765 pipefitters (0.8%) had such findings. The former group was responsible for insulating pipes and equipment on a daily basis; the latter group was comprised of individuals who routinely worked with bare, uninsulated metal piping and equipment. In contrast, shipboard repair of thermal insulation by Navy Machinist's Mates was normally restricted to minor patching under usual operating circumstances (Bureau of Naval Personnel, 1958):

***"MAINTENANCE AND REPAIR VALVES AND PIPING:
Aboard ship you are responsible for the routine maintenance of valves, and piping assemblies in your assigned spaces. In addition, the qualifications for advancement in rating require that you know how to make minor repairs to insulation or lagging in piping; how to reface valve seats and disks; and how to repack high-pressure valves. Unless the piping system and valves are in good condition, the connected units of equipment and machinery cannot be operated efficiently, and the safety of the ship's personnel may be imperiled."***

This restriction was due to the scope of what could be repaired at sea, the limited availability of parts and insulating materials, and/or the need for heavy equipment or specialized tools to perform major repairs. Additionally, the Navy developed "portable" or "removable" pads, or "insulation blankets", for use on access portals or surfaces/areas when frequent access was required. This reduced exposures to asbestos dust which resulted from removing and replacing hard covering (block/pipecovering and cement (mud)).

Navy Boilermen (BTs) were also expected to perform similar minor repairs on such piping as part of their routine duties. (BuPERS, 1956)

"As a Boilerman, you will be required to install or patch insulation and lagging on steam lines and on other fireroom piping. It is important for you to know what materials are suitable for the various services and to know how to apply these materials."

In general, the materials used to insulate piping include the insulating material proper the lagging or covering and the fastenings which are used to hold the insulation and lagging in place. In some instances the insulation is covered by material which serves both as lagging and as fastening."

...

"Insulating materials must always be selected with regard to the temperatures to which they will be exposed. In addition to the actual insulating characteristics of the material such characteristics as structural strength, resistance to shock and vibration, chemical stability, fire-resistance, and ease of application and repair must be considered. Insulating materials commonly used on high-temperature piping include magnesia-asbestos composition, mineral or rock wool, asbestos, fibrous glass and several types of insulating cements."

...

"Asbestos is used for many insulating purposes and is provided in various forms Asbestos cloth is used as lagging over insulating material on valves fittings flanges and pipes. Asbestos felt is used for both low-temperature and high temperature insulation. Flameproof asbestos in the form of soft flexible sheet is used for lagging and insulation where space does not permit thicker or more rigid forms of insulation."

While performing such minor and occasional tasks involving external thermal insulation, the exposure of Sailors – either Machinist's Mates or Boilermen – to airborne asbestos fibers was not considered to be excessive. Again, under shipyard or "tender" conditions where there could be a substantial amount of such work being performed, strict dust controls were mandated. However, when considering the actual time and duration of these limited and infrequently-performed tasks while underway at sea, or in port by the ship's crew, the total exposure (dose = concentration x time) to airborne asbestos fibers was not considered by Navy occupational health professionals to be excessive or hazardous. (BuMED, 1961a) When possible, control of fiber release during the dustiest task of removal would be aided through the application of water – however, in some emergent conditions when hot steam system components required immediate attention, the use of such wet methods could be catastrophic.

In Mangold's study of personnel who had been working under the historically less restrictive occupational exposure guidelines of 5 MPPCF that were followed during the decades preceding his study reported in 1970, marine machinists and machinists had "positive chest x-rays" in 0 of 490 (0%) and 1 of 536 (0.2%), respectively. These two groups comprise the trades that would most commonly work directly with equipment located in shipboard machinery spaces – such as valves, pumps, and turbines. The "boilermakers" in this study (tradesmen actually constructing, making major repairs, and re-building boilers – not operating and maintaining them like Navy

Boilermen – had “positive chest x-rays” in 4 of 115 (3.5%). At this point in time, the association of a shipyard “Boilermaker’s” tasks with only occasional work with asbestos-containing materials and the excessive risk of developing an asbestos-related disease were just beginning to be appreciated (Mangold et al., 1968, Mangold 1969c, Selikoff, et al., 1979). There were 574 individuals included in the category of “electrician”; there were no individuals with “positive” chest x-ray findings in this large group. As a control or comparison group in this study, 1 of 420 clerical workers (0.2%) had a “positive chest x-ray”. The “marine machinists” (also called “outside machinists”) performing tasks like removing and replacing shipboard machinery, had “positive chest x-rays” in 1 of 536 (0.2%) – similar to that of the control group of clerical workers. For comparison with active duty US Navy personnel, the “corresponding” shipyard job categories and day-to-day responsibilities of shipyard workers differed significantly from these Sailors with respect to intensity, duration, and frequency of potential airborne asbestos exposure. Navy Machinist’s Mates (MMs), Boilermen/Boiler Tenders/Boiler Technicians (BTs), and Enginemen (ENs) primarily operated the machinery, and performed limited maintenance and repairs when necessary in order to keep the ship operating. Major repair operations were restricted to yard periods, or, when necessary, periods of availability with a Navy tender using skilled personnel and specialized tools and equipment. The differences in the type of work and exposure to asbestos fibers between shipyard workers and operators are discussed and accounted for by Williams and co-workers (2007). Table I is derived from Mangold and co-workers, 1970):

TABLE I: INCIDENCE OF POSITIVE CHEST X-RAY FINDINGS IN OCCUPATIONAL GROUPS

Occupational Group	No. of Persons In Group	No. With Pos. X-Ray Findings	Percent Having Pos. X-Ray Findings
Shipfitters	890	6	0.7
Sheetmetal Workers	489	6	1.2
Forge Workers	32	0	0.0
Welders	998	11	1.1
Machinists	536	1	0.2
Marine Machinists	490	0	0.0
Boilermakers	115	4	3.5
Electricians	574	0	0.0
Pipe Coverers & Insulators	104	22	21.2
Pipefitters	765	6	0.8
Shipwrights & Joiners	228	0	0.0
Electronics Mechanics	280	0	0.0
Painters	263	4	1.5
Riggers	664	1	0.1
Temp Service Mechanics	143	1	0.7
Clerical workers	420	1	0.2

Due to the potential for shipyard insulation workers to experience frequent, intense, and prolonged periods of direct work with asbestos-containing materials in the shipyard setting, the emphasis of the Navy’s program, as well as the programs established under US statutes, such as the Walsh-Healey Act (1936) and the “Safety and Health Regulations for Ship Repairing” (1960), were principally directed at shipyard exposures to airborne asbestos fibers for both the employed

civilian personnel in their daily tasks – as well as active duty Sailors during shipyard periods as discussed by Wynkoop (1947) and Franklin (1964). The multiple “components” of the Navy asbestos control program, as well as the program required under the “Safety and Health Regulations for Ship Repairing” (DoL, 1960) existed to control and minimize untoward exposure to airborne asbestos fibers from thermal insulation materials. Control of exposure was effected through the adoption of an occupational exposure level (OEL) based upon the best available scientific and medical information at the time; establishment of the methodology to evaluate exposures; use of industrial hygiene control measures (local exhaust ventilation; wet methods); use of personal protective equipment including respiratory protection, product substitution; periodic medical evaluations; recordkeeping; and local training and awareness programs – all required, as necessary, based upon the potential for the release of asbestos fibers from friable materials.

45. The review by Dr. PRD Williams and co-workers (2007), as well as the large studies of US Navy shipyard workers conducted by Mangold and co-workers (1970) and British dockyards by Harries (1968; 1971), discuss the traditional tasks and practices which resulted in airborne asbestos fiber exposures of electricians – a trade that was not considered to be at risk from working with asbestos-containing materials during the pre-OSHA period. The airborne asbestos fiber concentrations were less than the recommended exposure guidance level (pre-OSHA) or statutory occupational exposure limit (post-OSHA) during the various time periods until 1976, when the OSHA Asbestos PEL became 2.0 f/cc. Prior to 1976, airborne asbestos concentrations to electricians were not generally thought to result in clinically significant exposures. As the OSHA Permissible Exposure Limit (PEL) was lowered after 1970, the responsibilities of the employer were defined while the widespread dissemination of information concomitantly occurred. The April, 1971 issue of “The Electrical Workers’ Journal” contains an article on the newly promulgated “Occupational Safety and Health Act” and states that:

“AFL-CIO President George Meany termed the Occupational Safety and Health Act “a long step down the road toward a safe and healthful work place,” but he stressed that “achievement of that goal will not be automatic.” He warned that labor will keep a watchful eye on the enforcement machinery, stressing that, if it doesn’t work effectively, “we will immediately petition Congress to strengthen and improve it.” (Pillard, 1971)

Mr. V Cohn’s 1972 Washington Post article reflects the knowledge of the nation’s largest federation of unions – it is titled: “AFL-CIO Warns on Asbestos Cancers”. The International Brotherhood of Electrical Workers (IBEW) was an affiliate of the AFL- CIO. The June, 1973 issue of “The Electrical Workers’ Journal” contains an article detailing “The Target Health Hazards” under OSHA – which lists “Asbestos” prominently as the first of the five nationally-targeted health hazards. This article even lists the applications of asbestos under:

“Where is it? The heat-resistant properties of asbestos have led to many uses – for example, protection against fire, insulation, brake and clutch linings, building materials, filter materials, and in plastics. The raw material and end-products are found nearly everywhere.”

This article also lists the hazard and health consequences of asbestos exposure. The June, 1978 issue of “The Electrical Workers’ Journal” contains another article dealing with Asbestos Related Diseases. Dr. Irving Selikoff, writing in “The Asbestos Worker” (for the Association of Heat and Frost Insulators and Asbestos Workers – another affiliate of the AFL-CIO) discusses “New Mask Undergoes Field Test” in the May, 1969 issue and his efforts to find an air-filtering respirator which is both suitable, as well as acceptable, to insulation workers.

46. The information possessed by the US Navy, the Maritime Administration, and other Federal Departments and Agencies with respect to the specification and use of asbestos, and the health

hazards associated with its use onboard US vessels, far exceeded any information that possibly could have been provided by an equipment manufacturer. An equipment or product manufacturer had absolutely no authority, responsibility, or control over the US Navy or private workplace, or the respective personnel – all essential aspects in hazard communication and control. The Navy had long recognized and accepted the responsibility of command, or the “employer’s role” as the controller of the workplace, in the practice of occupational safety and health. This was also recognized under the Occupational Safety and Health Act; the Act was put into effect through the employer – with the adherence of the employee. It must be noted that the asbestos-related and other standards of the Occupational Safety and Health Act of 1970 were mandatory for all private employers including shipyards; OSHA did not include Executive Branch Federal workers nor the military. However, under Section 6 of this Act, Federal Departments and Agencies were directed to establish and maintain comprehensive and effective occupational safety and health programs consistent with the standards of the Act. Additionally, Presidential directives (Executive Orders) were issued in 1971 (EO 11612), 1974 (EO 11807), and 1980 (EO 19126) requiring each Federal Department or Agency to comply with the OSHA standards. A series of wide-reaching Navy directives, referenced above, were promulgated to meet these requirements. It is obvious that, based upon the knowledge at any given point in time, the Navy and the Maritime Administration were fully aware of the health hazards of asbestos and had programs dating back before World War II to control exposure of personnel and monitor their health; and that this knowledge persists through the present day. The knowledge of the hazards created by the use of asbestos containing materials was weighed with respect to the vital benefits provided by its use. The Navy controlled asbestos exposure consistent with the then current state of accepted scientific and medical knowledge balanced by needs for national defense. The Navy’s asbestos control program, at all times discussed above, was multifaceted and complex, and included hazardous process identification, engineering controls, use of alternative materials in accordance with Navy specifications and contract requirements, personal protective equipment, training and education, and medical surveillance – all when indicated by the level of exposure to airborne asbestos fibers. A mere warning statement, possibly confusing and always superfluous – and perhaps even incorrect and in direct opposition to established Navy policy and procedures – would have added nothing to the Navy’s existing occupational health program for the control of asbestos exposure to the hazardous concentrations universally accepted at various points in time from the 1920s until the present time. However, in the mid-1960s, primary asbestos manufacturers of thermal insulation materials began placing a warning on their friable thermal insulation products (Johns-Manville, 1964); this label contained information similar to that later required for such friable products under the Occupational Safety and Health Act asbestos standard (DoL, 1972). Additionally, it must be remembered that the Navy’s occupational health program existed through periods of war and military conflicts and was an additional consideration in the decision-making process at all levels of the Navy command structure.

47. Concomitant with the dissemination of information within the Navy and the Federal Government, as alluded to briefly above, labor unions also were involved with advocating and ensuring compliance with the new Federal standards (Cohn, 1972). Dr. IJ Selikoff, a physician deeply interested in the identification of risks and exposures among a much more intensely-exposed group – namely the insulation workers in the United States, worked closely with the AFL-CIO’s affiliate, the Association of Heat and Frost Insulators and Asbestos Workers, during the 1960s and 1970s to assess asbestos exposures, confounding factors, and the development of disease. In 1965, Dr. Selikoff writing with Churg and Hammond noted.

"Scattered case reports have previously been recorded of neoplasms among insulation workers, including both lung cancer and mesothelioma of both the pleura and peritoneum. A lung cancer has also been reported in a workman in a factory making asbestos insulation. However, these reports, while interesting and valuable, could not establish an association between the two conditions."

In that same year, Hammond (1965) commented on the level of inhalation asbestos exposure of full-time insulation workers who experienced daily exposures to levels of airborne asbestos fibers also far greater than those of sailors "steaming ships" and performing occasional work on steam systems with external, asbestos-contain insulation:

"I believe that there was hardly anybody a few years ago who would have suspected that there was a lung cancer risk in this group of insulation workers. These men were not asbestos weavers nor asbestos miners, and nobody at that time had suggested an increased risk at all for insulation workers."

Dr. Selikoff further noted that the association between general shipyard work performing non-routine work with insulation, and the potential for the development of asbestos-related lung disease was not recognized before 1968:

"In 1968, the possibility that asbestos-associated disease might be an important problem of shipyard workers was suggested." (Selikoff, et al., 1979)

In his address to the delegates of the Twenty-first Convention of the Association of Heat and Frost Insulators and Asbestos Workers in 1967, Dr. Selikoff noted that cigarette smoking was a major factor in the development of lung cancer. At this time, Dr. Selikoff also noted that mesothelioma was a very rare disease which may also be related to some types of asbestos exposure among insulators.

"Also, by the way, I did not see a cancer of the lung in an asbestos worker who smoked cigars or an asbestos worker who smoked pipes, if he didn't smoke cigarettes at the same time. If levity were in order at this time, I perhaps should say, "Put that in your pipe and smoke it." (Laughter.)"

***...
"And something else: There is a very rare disease-and you can break your teeth on this one-called mesothelioma. Nobody knows too much about it. I will tell you why nobody knows about it. Because it has been so rare that it is not even coded by the U.S. Bureau of Statistics. It is not separately coded in the International Classification of Causes of Death. It is very rare, so rare that at my hospital, from 1930 to 1960, we only saw three cases, and we have a huge hospital, very active."***

In 1965, Newhouse and Thompson (1965a, 1965b) reported cases of asbestos-related disease in individuals who were identified as not having worked directly with asbestos-containing materials. These "bystander" exposures were scientifically untested and unique with respect to the type of asbestos (crocidolite or amosite) – and this conclusion was not universally held by major asbestos researchers (Hueper, 1966). Selikoff, in responding during the "Symposium on Asbestosis", published as "Pneumoconiosis: Proceedings of the International Conference, Johannesburg, 1969", stated that he had contacted Dr. Newhouse to advise her that he had reservations regarding the current scientific ability at this time to justify giving an estimate of the risk associated with indirect "environmental exposure" of bystanders or family member and stated:

"It may be very much overrated. All we can say at this time is that there is a significant occupational risk. We have yet no cohort studies on how many people have been exposed in neighbourhood areas or in family exposures. It probably is very much less than we think."

...Therefore, unless we can identify true absence of occupational exposure, we have to regard labels of pure family or neighbourhood exposure with caution."

I think that this is very important. All of us are faced with a very practical problem. What exactly is the exposure with which asbestos disease is associated? We must define this. At the present time, our definition is only that, in specific industrial circumstances, a significant risk occurs. This, I think, can be controlled if we put our minds to it. On the other hand, much more data are necessary before we can label the magnitude of non-occupational exposures with any degree of accuracy." (Selikoff, 1970)

In sum, the scientific and medical data of the period extending through the mid-1960s had not even identified a risk of cancer – specifically mesothelioma – in individuals who were occasionally handling and working with asbestos-containing materials, or those having exposures to inhalable asbestos at low or intermittent levels compared to the widely-accepted occupational exposure level of 5 MPPCF. This conclusion is fully supported by the leading asbestos-disease investigators of the era – for example Irving J. Selikoff, MD, writing reflectively with DH Lee, MD in 1979:

“The decade of the 1960s provides a convenient time at which to terminate a historical view of asbestos disease. With admirable hindsight from the late 1970s we can see that the essential evidence had already been reported, but not yet assembled or vested with sufficient credibility to be entirely convincing. With few exceptions, the evidence at that time rested on scattered reports of small numbers of cases, and the cases themselves suffered from being either selected or simply those that happened to come to the attention of the reporter. The population base from which the cases came was seldom mentioned. The significance of pleural changes and the occurrence of mesothelioma in persons without a distinct history of exposure remained in considerable doubt. The idea that asbestos could be at least a cofactor in the production of bronchogenic carcinoma was far from fully accepted. That parenchymal asbestosis was very likely to occur in those who had been exposed to heavy dosage in the early years of the industry was clear enough, but what effect environmental controls that had been introduced in the late 1930s might have upon its future prevalence was unknown. The possibility that quite low dosages might have grave consequences 30 or more years after first exposure was still unproven.

Many things were needed to confirm the suggestions that were emerging from the studies up to that time. Most importantly, systematic epidemiologic investigation was needed of large cohorts drawn from various types of industry, with the inclusion of adequate control populations. Some of these were already organized, but it was too early for the results to be meaningful. We now know that much of the negative evidence stemmed from coming to conclusions prematurely, before the slow processes of carcinogenesis had had a chance to make themselves evident. We now know also that reduction of heavy exposures that lead to early death would reveal such slowly developing diseases as mesothelioma and bronchogenic carcinoma with increasing clarity. But foreknowledge was not available at the time, although some investigators suspected that the auguries were not good. More sophisticated and sensitive ways of recognizing the disease processes at an early stage, before the appearance of marked radiographic changes, were badly needed. A series of international conferences, some already in the planning stages, were to accelerate these developments greatly. Those who felt that it was an exciting time were not to be disappointed. The excitement has not even yet been entirely dissipated.”

This conclusion is also supported by the earlier articles which were published by Dr. Selikoff in the mid-1960s (Selikoff, Churg, Hammond, 1964; Selikoff, Churg, Hammond, 1965; and Selikoff, 1967).

WHAT COULD AN EQUIPMENT MANUFACTURER HAVE TOLD THE US NAVY, OR ANY INDUSTRIAL OR COMMERCIAL CUSTOMER?

48. When addressing what asbestos-related information an equipment or product manufacturer or vendor could have provided to the US Navy, the Maritime Administration, or a Department or Agency of the Federal Government, or to any industrial or commercial customer, that it did not already have and consider in its specification and use of asbestos-containing materials, one must realize what was known about the health hazards of asbestos and when it was known.

49. The United States Government's and the US Navy's knowledge regarding the applications of asbestos and the health effects represented the state of the art. During the period from the early 1920s to the late 1960s, there was nothing about the hazards associated with the use of asbestos containing products used on or in equipment on United States Navy ships known by an equipment manufacturer that was not known by the United States Government and the United States Navy. The expected, routine use and handling of asbestos-containing materials during normal shipboard operations simply presented no significant hazard that was understood by science and medicine of the time period – much less a “special hazard”. “Toxicity” is a property inherent in all chemicals as a consequence of its concentration. In the practice and application of toxicology, it is well known that ALL chemicals are toxic as a consequence of dose (Paraselsus [1493-1541]: “*Sola dosis facit venenum*”—“Dose alone makes the poison”) and that “hazard” is a consequence of how a chemical is used. All chemicals under certain conditions can cause harm to a living organism. So, all chemicals may present a hazard under certain conditions. The “conditions of use” and “exposure”, and the realization that harm can result define a “hazard” – and the need to control it. A “special hazard” would then be one that is extraordinary, or extremely severe or not expected. Exposure to airborne asbestos fibers of a sufficient concentration for a sufficient period of time could cause fibrosis and damage the lung (asbestosis). The Navy's knowledge and “occupational health program” to control excessive exposure to asbestos predates even the scientific or medical proof that asbestos could cause lung fibrosis by Cooke in 1924, and the use of the term “asbestosis” by Sir Thomas Oliver in 1925. In 1922, the potential for this inorganic dust to cause harm was recognized by Dublin in his “Notes on Preventive Medicine for Medical Officers, United States Navy” and Navy physicians were given a precautionary notice. In this document, Dr. Dublin addresses asbestos exposure as one of the “Occupational Hazards and Diagnostic Signs: A Guide to Impairments to be Looked for in Hazardous Occupations.”

50. By the 1950s, control of exposure to airborne asbestos fibers based upon the concentration and duration – sufficient to prevent asbestosis – was considered by medical authorities, both international and domestic, to concomitantly control the (then believed) causal relationship between asbestosis and pulmonary cancers. (Smith, 1952; Doll, 1955; Hueper, 1966) The association of one type of amphibole asbestos with the development of a rare and uncommon type of cancer, mesothelioma, was not demonstrated until several years later with the work of Wagner and his coworkers in 1960. (Wagner et al, 1960) Wagner and coworkers established the association of mesothelioma with a specific type of asbestos, crocidolite, under conditions which were totally different than those found in naval applications or onboard ship – and to a chemically different form of asbestos. The proven association of amosite (the type of asbestos used extensively for thermal insulation on Navy combatant vessels of this period) and mesothelioma was not established until the work of Selikoff and his associates in 1972 (Selikoff et al, 1972). Throughout the period from 1950 until the mid-60s, limiting exposure to airborne asbestos fibers to levels below those which would cause asbestosis, would concomitantly control the development of cancer – either lung cancer or malignant mesothelioma. Federal programs were based upon this sound, and widely held concept.

51. With the increasing use of asbestos in World War II, the Navy expanded its occupational health programs for asbestos and other chemical, physical, and biologic agents which were consistent with the state-of-the-art for each of these potential hazards at that time; these wartime programs were discussed by Captain Brown in 1941. Philip Drinker, writing as the United States Maritime Commission's Chief Health Consultant to the Navy's Bureau of Ships in 1945, recommended that 5 MPPCF be used as the industrial hygiene control level – even before that level was formally recommended by the American Conference of Governmental Industrial Hygienists in 1946. This is the same value that was used as the occupational exposure level in the noteworthy “Fleischer-Drinker study” published in 1946. This study measured total dust, and asbestos dust, in four US Navy shipyards and onboard ships during various operations, and also evaluated medically-associated outcomes.

52. In one of his early roles as a consultant to the US Maritime Commission and working before

the "Minimum Requirements" were enacted in early 1943, Philip Drinker, then at Harvard School of Public Health, led five US Navy officers in the performance of a general Industrial Health Survey of the Bath Iron Works in September, 1942. (Drinker, 1942) This survey reviewed the industrial shore facilities and ships under construction. The ventilation in the Pipe Covering Shop was qualitatively assessed and recommendations were offered :

"The conditions in this shop present a very real asbestosis hazard and immediate steps should be taken to segregate the most dusty processes into a well ventilated area. Local exhaust ventilation of proper design should be installed; however, if conditions can not be completely controlled in this manner, then suitable dust respirators should be worn by the workers. Periodic physical examinations of the chests of all workers should be made. Every six months is a reasonable interval."

During this survey in 1942, Drinker and his team noted that a variety of respirators were available for issue, at no cost, in the Tool Room. It was further noted that a program for the repair, cleaning, and sterilization for these respiratory protective devices was in place.

53. In December, 1944, WC Dreessen (a "Surgeon-grade officer" with the US Public Health Service and lead author in the earlier US Surgeon General's Report: Public Health Bulletin No. 241) and Lieutenant Commander WE Fleischer, USNR (a Navy physician assigned to the US Maritime Commission's East Coast Regional Construction Office and lead author in the later "Fleischer-Drinker Report"), formally investigated Bath Iron Works (BIW) regarding "Asbestosis from Amosite Pipe Covering at Bath Iron Works". The BIW shipyard was now performing work under the statutory "Minimum Requirements for Safety and Industrial Health at Contract Shipyards" (1942). As the Chief Health Consultant of the US Maritime Commission, Drinker directed this investigation as his office had ***"heard that there was concern among the pipe covering crews who feared that the amosite was causing some respiratory troubles."*** In the report of their findings, these US Government representatives provided the following:

- "1. Provide adequate ventilation at all points where dust is created when handling Asbestos Products and Diatomaceous Earth Products capable of producing Silicate dust.***
- 2. Require all employees to wear suitable approved respirator when engaged in any work where there could be exposure to Asbestos Dust.***
- 3. Provide pre-employment medical examination of the chest area for those who are employed in work where there is exposure to Asbestos Dust. (The purpose of the pre-employment examination is to eliminate prospective workers who have respiratory ailments or who are susceptible to respiratory ailments.***
- 4. Provide periodic medical and chest examinations for all employees engaged in work where there is an exposure to Asbestos Dust. It is suggested that such periodic medical and X-ray examinations be made at intervals of at least every six months."*** (Dreessen and Fleischer, 1944)

In follow-up reports of total and asbestos dust counts at BIW, the US Maritime Commission industrial hygienist performing the microscopic analysis discussed his findings (Thompson; 1945):

"In all counts except those taken in cutting asbestos, there appeared to be a great deal of material about 1 micron in diameter and of a very uniform size. This did not appear to be in the least fibrous, and I suspect it may be particles of cement which are used in the mixture. Certain of the basic materials used contain large quantities of diatomite."

Dr. CR Williams (1945) performed petrographic analyses of these dust samples at his Harvard School of Public Health laboratory. His results confirm that general area dust onboard ships has

variable concentrations of total and respirable asbestos – with the vast majority of dust in non-amosite cutting operations comprised of materials other than asbestos.

54. The Navy's occupational health program not only addressed asbestos exposure, but it had a significant medical component which contributed to advancing the state-of-the-art knowledge. In 1955, Mr. JR Sheehan, an industrial hygienist at the Long Beach Naval Shipyard, wrote to Mr. Webster Ay, the Secretary of the Asbestos Union #20 at that Yard (and one of the individuals involved in the production of the "Grim Reaper" Poster used nationally for asbestos hazard recognition and control since the 1950s), to inform him of the availability of a new medical test being developed by Hurley Motley, MD (at the University of Southern California) to measure early pulmonary function changes and encouraged its acceptance and use among the Yard's asbestos workers, pipe coverers, and insulators. This type of test later became commonly used as it was more sensitive than chest radiography in detecting early lung changes from dust exposure. In addition to industrial hygiene engineering controls, the Navy also developed task specific training for individuals potentially exposed to levels of asbestos exceeding 5 MPPCF.

55. By the 1960s, the then-recognized hazards of asbestos were becoming known within the relevant industries – that is to say, the manufacturers and major users of asbestos thermal insulation. The best scientists of the era were beginning to recognize the association between chronic asbestos exposure among insulation workers and the newly-recognized disease mesothelioma (Selikoff, Churg, Hammond, 1965). At the same time, the major thermal insulation manufacturers began placing asbestos safety caution labels on the packaging of their insulation products – Johns Manville in 1964 and Owens-Corning Fiberglas in 1967. The national insulators' union, and industry, began a major nationwide push to educate thermal insulation workers about the hazards of asbestos. (Selikoff, 1967) Still, the federal government, virtually every state in the Nation, and the world's entire scientific and medical communities universally followed 5 MPPCF as an acceptable continuous, daily occupational exposure level for asbestos. This was a level of exposure associated with asbestos textile manufacturing, career insulation workers, and virtually no one else. Individuals operating equipment with asbestos-containing thermal insulation, or those working with or handling non-friable, asbestos-containing materials in the performance of their duties were not considered to be at risk of developing any asbestos-related disease based upon their types of exposures – and the associated level, duration, and frequency of these exposures. Therefore, they were not typically provided with warnings about asbestos hazards that were thought applicable only to unrelated trades with much more intense exposures – unless the asbestos exposure and release conditions warranted such a warning – such as those found during a shipyard overhaul period – and that warning was associated with processes involving external thermal insulation containing asbestos and not the handling and use of gasket and packing materials, or electrical components. This practice was fully consistent with the state-of-the-art as discussed above by Dr. Irving Selikoff. No additional warning by a manufacturer and/or vendor of equipment (like turbines, boilers, valves, pumps, or electrical equipment), was going to change this well-accepted fact – until the period of OSHA with new scientific and medical information and correspondingly massively increased attention and research on this national "Target Health Hazard" (DoL, 1972). Under OSHA, the statutory, "Permissible Exposure Limits" for asbestos were appropriately lowered as the developing state-of-the-art knowledge indicated the need. Further Federal regulations and mandatory controls were enacted in the early 1970s; these regulations were placed on the employer of the workplace, or the business entity generating asbestos-containing waste, and covered literally all aspects of asbestos use, exposure, and disposal.

56. The occupational exposure level of 5 MPPCF continued to be used by the Navy, as well as other Federal agencies and many states, through the 1960s. However, this long-held "acceptable" occupational exposure concentration was re-evaluated in light of evolving scientific and medical knowledge and underwent incrementally significant reductions following the enactment of the Occupational Safety and Health Act in 1970. (US Congress, 1970) A national, statutory occupational exposure level, now called the "permissible exposure limit (PEL)", did not exist until the promulgation of the Occupational Safety and Health Act, and later as published

under the asbestos dust standards (DoL, 1972). Although when enacted, this national legislation specifically excluded military personnel in unique military workplaces and also did not address occupational health and safety during wartime or military conflict conditions, it did include private shipyards and all personnel working in those yards, as well as other industrial and commercial sites and facilities. The Navy had also adopted its own exposure standards (prior to OSHA) based upon the same occupational exposure levels later established as statutory limits under OSHA (BuMED, 1955; DoN, 1971; BuMED, 1973, and OPVAV, 1974). As mentioned previously, the Navy also took further additional steps to eliminate the use of asbestos as a thermal insulation through its "Asbestos Elimination/ Substitution Personnel Protection Program". (COMNAVSEASYS COM, 1975)

57. Similarly, under the US Environmental Protection Agency National Emission Standard for Asbestos (US Congress, 1971); National Emission Standard for Hazardous Air Pollutants for Asbestos – "Asbestos NESHAP" (EPA, 1973); and the Toxic Substances Control Act (TOSCA) (USEPA, 1976), asbestos became regulated as a controlled environmental pollutant. Even then, operators of equipment in occupational settings were not, under normal working conditions, expected to be at risk of exposure to asbestos dust levels in excess of the existing PEL. And, to the extent that specific working conditions at a specific workplace did create such a risk, under OSHA, the duty of educating, protecting, and warning the worker fell explicitly upon the employer, as well as the manufacturers of the asbestos materials at issue. Trade unions also became involved. The AFL-CIO – the federation of labor organizations which worked closely with Irving J Selikoff, MD to evaluate and control the hazards of asbestos exposure among their workers was also very active in the development of national labor legislation. The AFL-CIO President, George Meany, called the Occupational Safety and Health Act passed in 1970 **"...a long step ... toward a safe and healthy workplace."** (New York Times, 1970). When President Nixon signed this milestone Act of 1970, George Meany and other labor figures were present at the ceremony held at the Labor Department. As the control of exposure to asbestos was one of the five major health hazards targeted by this new legislation (DoL, 1972), the labor unions became even more active in identifying excessive asbestos exposures in the workplace and educating their members regarding asbestos hazards and the means of controlling exposure. This union activity actually dated back to the early 1960s. (Sickles, 1961; 1962) Under OSHA, the employers, unions, as well as workers themselves, were all considered to be the important components in maintaining safe and healthful workplaces. Most certainly, shipyard labor unions were very involved in the enactment and enforcement of these standards.

58. Indeed, the Navy stayed abreast of developments regarding the hazards of asbestos and developed sound approaches to the control of exposure to excessive asbestos fiber levels, as evidenced by several programs at various shipyards during the pre-OSHA period before 1970. In the late-1950s, Mr. WT Marr at Long Beach Naval Shipyard, where CAPT Wynkoop, USN had appropriately directed the attention of the Commanding Officers of ships entering the shipyard to the hazards of the overhaul period and provided support personnel and personal protective equipment in 1947, was investigating alternate sampling and measurement techniques for the evaluation of asbestos – well before the change from a methodology using particle counting to one evaluating fiber length and concentration. The "Grim Reaper" poster emphasizing the need for insulators to wear a respirator when working with asbestos was a product of unionized labor and the safety department at this yard in the early 1960s. At the Boston Naval Shipyard, Mr. Storlazzi was continuing to practice state-of-the-art occupational health and industrial hygiene which had been started by CAPT Jenkins in the late 1930s. One of the earliest commissioned Industrial Hygiene Officers in the Navy, Mr. Seymore Levinson, continuing the work in which he was trained in 1942, directed the industrial hygiene program at the Norfolk Naval Shipyard in the 1960s where he provided exposure assessments and recommendations at this facility. (Levinson, 1965; 1967; 1969)

59. The Puget Sound Naval Shipyard (PSNSY) had a well-established occupational safety and health program which included an asbestos control program. As practiced throughout the Navy, this program was based upon the worker's exposure potential. Mr. CW Richards was the

representative from Puget Sound Naval Shipyard in attendance at the Navy-wide "Pipe and Copper Shop Master Mechanics Conference" held in Boston in 1958. At PSNSY, specific program documentation dates back to the "General Safety Rules Manual" promulgated in 1950. (PSNSY, 1950) In this Manual, the following is stated:

"Wherever there are fumes, irritating vapors or heavy dust present in the atmosphere, respiratory equipment is necessary for your protection. Consult your supervisor for advice on any problem that may arise. (See Section N, Rules on Personal Health.)"

"N4. Wear dust type or air-fed respirators for chipping red lead paint, handling amosite or insulating materials, while dressing abrasive wheels, while working exposed to dust from sand blast operations (wet or dry), and for any other dusty process where effective ventilation cannot be obtained." [EMPHASIS ADDED]

The potential hazards of asbestos were recognized by both tradesmen and occupational health personnel. In addition to providing an overview of insulating materials, the Master Mechanic of the Pipe Covering and Insulation Shop (Shop 56; PC&I) manual on "Marine Pipe Covering and Insulation" adopted in May, 1961 addressed worker safety training.

"Marine Pipe Covering and Insulating" has been assembled through the research efforts of Shop 56 under the direction of the Master Mechanic.

Utilization of this technical trade manual in the field of pipe covering and insulating will improve the vocational and production skills of our present craftsman as well as to "afford intangible benefits in training of new employees."

Chapters I through III will present an interesting introduction to our Navy's magic fibers" which make possible unlimited operating temperatures and pressures in such critical piping as HIGH PRESSURE STEAM propulsion while affording maximum protection to our operating personnel.

Chapters IV through VI will introduce Pipe Covering and Insulating tools, machinery, and insulating material with their layout and installation.

Chapters VII through X will afford intangible technical data for reference or application.

It is with the profound interest and best wishes of our trade we present this manual." [EMPHASIS ADDED]

This 1961 Manual also provided handling guidance for insulation materials in order to minimize the generation of dust, as well as requiring the use of respiratory protection when appropriate. Using lay terminology and basic medical concepts, the Shop's Master forcefully addresses his supervisors and tradesmen:

"Characteristics of the pipe covering and insulating operations in the shipbuilding industries are such that proper personal safety precautions must be adhered to at all times. Each individual pipe coverer and insulator employee is required to check out and use a respirator when working in insulating areas where there is any danger from exposure to harmful insulating dusts. Supervisors should ensure that their men are properly protected at all times with proper safety equipment and adequate

ventilation. Supervisors are not relieved of responsibility by merely instructing their men to use safety equipment, they are obliged to follow up and ensure that protective measures have been implemented for their crew's health and welfare.

Industrial dusts of all forms have long been thought of as a production evil. Sometimes taken quite seriously, and sometimes taken with a grain of salt, or we might add sardonically, with a micron of silicosis.

Proper control of all harmful industrial dusts can be obtained only through the combined efforts of the workers and management working together to minimize exposures to critical dust and fumes.

The "old timer" or "smart character" may look on humorously as an informed and cooperating worker carefully adjusts his respirator before ripping off reams of amosite or asbestos piping insulation preparatory to a piping alteration. However, it will be the cooperating worker who will have the healthier pair of lungs at the end of the day.

While "Pneumoconiosis" is the technical term applicable for such infections as "Miner's Asthma", "Miner's Phythisis,"(sic) "Grinder's Rot," (sic) and many others, "Asbestosis" and "Silicosis" are the two most harmful and common lung infections of the pipe covering and insulating trade.

...

The infectious characteristics of insulating materials, such as diatomaceous earth (a form of amorphous Silica), asbestos dust, glass or rock wool, and Magnesite, are harmful and do damage to the respiratory system when breathed in excessive and constant amounts. [EMPHASIS ADDED]

The Shop's Master used a hand-drawn picture of the human lungs and airways to stress his point of physiologic fragility and the need to comply with safety and health precautions:

"An example of the lung structure with its delicate parts has been included to stress the importance of proper safety or health precautions while performing pipe covering and insulating operations." [EMPHASIS ADDED]

The Puget Sound Naval Shipyard's asbestos control program had many other notable developments. Mr. CA Mangold and the occupational health staff at the Puget Sound Naval Shipyard were also very active at this time developing worker education programs while controlling excessive exposure to airborne asbestos fibers in accordance with Navy instructions and statutory Federal requirements as they were promulgated. (PSNSY, 1950; Mangold, 1965; PSNSY, 1966; Mangold, 1967; Mangold, 1968; Mangold, 1969a,b; BUMED, 1969; Barboo, 1969; McBratney, 1969; Mangold, 1970; Beckett, 1976) Training lectures, such as "Practical Industrial Hygiene and Toxicology" were developed for employees and presented by the Industrial Hygiene Department. (PSNSY, 1965) Technical guides for ventilation (Mangold, 1967; Mangold, 1969a) and respiratory protection (PSNSY, 1966) were also developed by the Industrial Hygiene Department to aid supervisors in the performance of the safety aspects of their positions. Concerned about their medical monitoring findings in light of the industrial hygiene data for the insulators and other industrial trades at the PSNSY, the Medical Department not only informed the workers of their concern (Mangold, 1969a,b; PSNSY, 1969), but also took the initiative to disseminate their findings to other occupational health professionals both inside (Manning, 1968; McBratney, 1969; Mangold et al., 1970) and outside of the Navy (Mangold et al, 1968). The final

report of Mangold and his coworkers work on "Asbestos Exposure and Control at Puget Sound Naval Shipyard" (1970) was approved and released by the shipyard Commander, RADM EW Petrovik, USN in March, 1970. This Program was highlighted by the Navy Bureau of Medicine and Surgery for its excellence, and photographic images of shop and ship asbestos control measures in use at Puget Sound Naval Shipyard were put on display at the Bureau in Washington, DC. The information distributed to occupational health personnel throughout the Navy. (Barboo, 1969)

60. The Navy also took further additional steps to eliminate the use of asbestos as a thermal insulation through its "Asbestos Elimination/Substitution Personnel Protection Program" (COMNAVSEASYSCOM, 1975; COMNAVSEASYSCOM, 1976). As the general state-of-the-art medical knowledge regarding the inhalation of asbestos fibers evolved, as well as the development and availability of suitable substitute non-asbestos materials progressed, the Navy adopted a measured program to replace asbestos thermal insulation. As Vice Admiral Bigley, speaking for the Chief of Naval Operations, acknowledged in his letter dated 5 January 1979 to the General Accounting Office (Bigley, 1979):

"In the case of insulation specifications, changes were made as early as 1971 to specify that the Navy wanted materials with little or no asbestos. By late 1973, these specifications had been changed to call for asbestos-free materials. The fact, however, that these product specifications were changed to call for asbestos-free materials does not mean that ship-builders must stop using asbestos products. Many ship-sets of asbestos containing products, purchased to earlier versions of the product specification had already been bought and in some cases installed. Tens of thousands of pounds of asbestos products remained in warehouses, aboard ships, and in shipyards, in active use. With no positive action by the Navy, many additional years would pass before the asbestos products were exhausted. Although, in some cases, separate action by some Navy components resulted in the asbestos-free products being used prior to 1973 or 1974, the overall Navy policy prohibiting the use of such material could not be promulgated until we had some assurance that it could be followed. By 1975, asbestos-free materials were generally available to all Navy agencies and the no-asbestos policy statement, NAVSEAINST 5100.2 of 24 October 1975 issued."

Admiral Bigley further noted that although ship purchase contract specifications were changed for some ship classes in 1971, the change for all ships classes was not accomplished until later:

"... Ships well under construction and already insulated at that time continued through to delivery as late as May 1978 with asbestos insulation. Consequently some ships were delivered with asbestos thermal insulation since 1973."

Admiral Bigley (1979) further addressed the removal of asbestos from existing shipboard installations:

"Regarding removal of all asbestos aboard Naval vessels, Navy policy has required replacement of asbestos insulation with substitute material when insulated equipment and machinery are repaired. Recently, this policy has been modified to require, in addition, selective replacement of asbestos insulation in those high-maintenance areas where repairs may be anticipated during the subsequent operating cycle of the vessel. During the next five years, implementation of this policy will result in the removal of all shipboard thermal asbestos except that 30 to 50 percent which is normally untouched during the life of the ship."

The concept of a one-time total asbestos removal on all ships has been under intensive review to determine if such a policy revision is technically and economically feasible. Initial analysis does not justify such a policy change. While there is no intention to conduct a trade-off of human health for maintenance and repair funds, the funds involved are substantial. As indicated above, the estimated cost to reinsulate just three classes of ships (frigates, destroyers, and submarines) is \$965.13 million. It is reasonable to assume that the estimated cost for total asbestos replacement in 'all ships' will approach two billion dollars. The true cost is likely to increase significantly because of delay and disruption effects, increased overhead charges due to longer overhauls, and increased shipyard manning to handle the added work. This enormous cost is not the only reason that the Navy has not adopted a one-time total asbestos removal policy. Other factors which support the present policy are the following:

a. During the life of a ship, 30 to 50 percent of the total asbestos insulation will never be touched except for painting or making minor repairs to the lagging cover material. Measurements show that operating ships equipped with asbestos insulation have airborne asbestos levels at or below 0.1 fibers per cubic centimeter. This value is comparable to the ambient level reported for the City of Philadelphia by Dr. Irving Selikoff, a well known asbestos expert. Therefore, on the basis of existing information, a properly maintained and operating ship should not present an active asbestos hazard.

b. The Navy requires and enforces stringent asbestos work standards which control exposure of workers to asbestos dust during ship repair. By minimizing the amount of asbestos work done, the potential exposure, residual dust, and overhaul cost are minimized.

c. Fibrous glass and calcium silicate products are being used as asbestos replacements. The National Institute for Occupational Safety and Health has recommended controls for fibrous glass work that are nearly identical to the controls now imposed for asbestos work. It seems reasonable to assume that if the Institute recommends nearly identical controls for two similar substances, comparable hazards could be known or suspected. Therefore, it is not at all certain that wholesale replacement of asbestos products gains any medical advantage at all.

d. Despite the enormous cost, replacement of asbestos thermal insulation in ships will not eliminate asbestos exposure of civilian and military Navy personnel. According to the National Institute for Occupational Safety and Health, asbestos dust is everywhere. Low but easily measurable levels of airborne asbestos dust are found in the air of cities throughout the country, much of it generated by automotive brake and clutch linings. Asbestos is used in so many products that most of the U. S. populace unknowingly encounters it daily."

61. As discussed previously, the potential exposure of active duty Sailors to significant levels of asbestos fibers was only recognized under unusual conditions – such as periods in which ships were “in the yard” for overhaul or undergoing significant maintenance or repair (Wynkoop, 1947). Similarly, based on the state-of-the-art in industrial hygiene and occupational medicine available

at the time, the duties that were thought to put civilian shipyard workers at risk for potentially significant asbestos inhalation exposures were largely limited to prolonged installation and removal projects by workers in the pipecovering trade (insulators). The Navy had both a well-based and well-established program for the control of the hazards of asbestos based upon the state-of-the-art, and, in consideration of its responsibility for national defense, made appropriate and informed decisions to specify and use asbestos for Navy ships. These programs were appropriately delivered through the Commanding Officers of each Naval activity – the individuals with ultimate Navy authority and responsibility. There was not an equipment manufacturer, nor a vendor, in a position to offer better advice to the US Navy before the enactment of the Occupational Safety and Health Act in 1970. And after 1970, and through the present time, the Navy's occupational health program continues to reflect the state-of-the-art in national safety and health policy and procedures, and to maintain readiness for national defense.

DISCUSSION AND ANALYSIS OF RISK-BALANCING BY THE NAVY RELATIVE TO ASBESTOS EXPOSURES AND THE HEALTH OF NAVY DEPARTMENT PERSONNEL

62. The Navy weighed its knowledge of the hazards created by the use of asbestos containing materials against the vital operational benefits provided by its use. The Navy controlled asbestos exposure consistent with the then current state of accepted scientific and medical knowledge balanced by needs for national defense throughout the various periods of its use. The Navy's asbestos control program, at all times discussed above, was multifaceted and complex, and included hazardous process identification, engineering controls, use of alternative materials in accordance with Navy specifications and contract requirements, personal protective equipment, training and education, and medical surveillance – all when indicated by the level of exposure to airborne asbestos fibers.

63. In all, it was the Navy (or analogously Coast Guard and Coast Guard personnel), with Congressionally-designated authority for operating and controlling the shipboard and activity/facility environments, workplaces, and types of materials, methods, and tasks to which Navy Sailors were assigned and where civilian personnel worked. The Navy accepted this role and responsibility in the performance of its mission. The Navy established and followed an occupational health program that protected its personnel – its most vital resource – so that they could carry out their tasks in support of the Navy's mission. Without its Sailors, a ship would be nothing more than an object either moored to a pier or floating aimlessly upon the sea; without its ships – and its Sailors – there would be no Navy. The Navy's civil service personnel were no less expendable as essential participants in maintaining the Navy's state of readiness.

64. As discussed above, Sailors in the engineering ratings "steam the ship" by operating the equipment. While it is certainly true that maintenance and minor repairs are performed, the vast majority of time is spent operating the various steam-driven equipment. The major units of propulsion machinery onboard a Navy warship (along with their appurtenances and associated equipment like piping and valves) are specifically designed to be highly reliable pieces of equipment which require nominal maintenance during normal operation. During the periods relevant to this report, the types of tasks which were routinely performed by shipboard personnel while operating this equipment were not considered by Navy occupational health professionals to result in exposure to asbestos fibers which would exceed the allowable occupational exposure level; they were not considered to be hazardous tasks – at least with respect to asbestos. To the extent Sailors experienced any exposures to asbestos-containing materials associated with equipment during their normal duties onboard ship, except in exceptional circumstances, these would typically have been medically and clinically insignificant and well below the allowable permissible exposure limits of the period. The major contribution to meaningful asbestos concentrations onboard a Navy ship of this era was from amosite asbestos fibers released from friable thermal insulation used on piping and other steam systems throughout the ship. However, even these airborne fiber levels were well below the accepted exposure levels of the period and

not considered to be hazardous to personnel.

65. Navy and civilian personnel working onboard ships and other vessels obviously worked around various equipment ranging in size from the very small – to the enormous. However, except in exceptional circumstances, Navy Sailors operating and maintaining equipment while performing accepted work practices would not typically have been exposed to airborne levels of asbestos fibers arising from gaskets, packings, or insulation on any piece of equipment which exceeded the accepted occupational exposure levels at the time. If exposure to airborne asbestos fibers was expected to exceed the accepted occupational exposure level at any given period in time, both during the pre-OSHA and post-OSHA periods, personal protection and other industrial hygiene controls were required. It should be noted that the equipment used in a Navy ship's machinery spaces – like turbines, boilers, pumps, valves, etc. – are typically shipped and installed without external thermal insulation. If thermal insulation was required by Navy specifications, the external insulation was provided and installed by the shipbuilder or repair activity after initial installation.

66. The presence and content of asbestos in thermal insulation, as well as gaskets and packings and other materials used in naval construction, is variable. Unless qualitatively and quantitatively determined in a scientific manner, the presence, type, and concentration of asbestos cannot be determined in either the material or in the air. From the industrial hygiene standpoint of controlling potential hazardous inhalation exposure to asbestos, it may be assumed that much of the thermal insulation and other materials, such as gaskets and packings, used in the construction and maintenance of naval vessels contained asbestos roughly during the era of the 1940s through the 1960s; however, only proper evaluation and determination by trained and qualified individuals can scientifically and conclusively make the determination. Without such evaluation, it cannot be known whether and to what extent the products, and the "dust" purportedly identified by witnesses not trained in applicable industrial hygiene methods, actually contained asbestos.

67. The Navy's total occupational health program operated within the Navy organizational structure (chain of command) and was designed to maintain functionality in the completion of the Navy's mission while controlling untoward exposure to airborne asbestos fibers to all Naval and civilian personnel. The ability of the Navy to operate and fulfill its mission rests upon many critical elements, the greatest of which are its Sailors. However, real world considerations such as funding, political and other current events, and natural and man-made catastrophes also impact senior Navy leadership's final decision in all matters. By the very nature of the Navy's mission, it is a combatant force and the Navy's leaders ("war fighters") must thoughtfully elect to place Sailors "in harm's way" to protect the country and its vital interests – as directed by President. Although these actions may result in casualties or death of Navy personnel, these types of decisions must be made for the good of our Country – its daily existence, its defense, and its survival. The Navy's occupational health program, including its asbestos exposure control program for over the vast majority of the 20th Century, was directed at maintaining a fit and healthy fighting force in support of accomplishing the Navy's mission and maintaining its combatant and support vessels, aircraft, missiles and other essential equipment – as well as providing essential occupational health resources for its civilian personnel.

68. As the occupational exposure level for exposure to airborne asbestos fibers decreased over the period of the late 1960s, and more so in the early 1970s under OSHA, the Navy and private, regulated shipyards and other industries further increased their vigilance for the control of exposure and instituted further industrial hygiene controls including: the substitution of asbestos in thermal insulation where possible; use of products containing lower amounts of friable asbestos; increased training; control of potential exposure to asbestos fibers of non-involved or unprotected personnel; posting of a warning; and the designation and education of individuals specially trained and equipped to handle asbestos in order to minimize the release of asbestos fibers. The use of asbestos-containing products has continuously decreased since the late 1960s and the potential for direct and background exposure has concomitantly decreased. The

increased control of potential exposure to respirable asbestos fibers was performed by the Navy while it still maintained a fighting force and provided for the Country's national defense. In addition to the post-OSHA regulations, as a matter of practicality and economic necessity, regulated industries also followed the trend of removing and replacing, or encapsulating/enclosing, potentially friable asbestos sources and materials. After the late 1960s, the composition of any thermal insulation, construction, or other previously known asbestos-containing product cannot be assumed.

69. As described above, the expertise of the Navy, with respect to the specification and use of asbestos, and the health hazards associated with its use onboard Navy vessels, far exceeded any information that possibly could have been provided by an equipment manufacturer. Additionally, the boiler, turbine, electrical, and auxiliary equipment manufacturers have absolutely no authority, responsibility, or control over the operating workplace or personnel – both essential aspects of hazard communication. Concomitant with the huge increase in shipbuilding during World War II, the Navy developed a robust and multi-faceted occupational health program which addressed many health risks. Over a quarter-of-a-century before the enactment of the Occupational Safety and Health Act of 1970 (US Cong, 1970; PL 91-596), the Navy had an asbestos control program in place which contained most of what was later required for non-military workplaces under this first national legislation controlling occupational exposure to asbestos. The Navy's program far exceeded the mere provision of a warning placard or note in an instruction or operation manual. The major aspects of the Navy asbestos control program existed before OSHA and have continued, with modifications, to remain consistent with the evolving state-of-the-art knowledge and statutory requirements of OSHA. The Navy's early program included the:

- (1) adoption of an occupational exposure level (five million particle per cubic foot (5 MPPCF);
- (2) establishment of the methodology to evaluate exposures;
- (3) training and equipping an occupational health team with state-of-the-art knowledge and equipment;
- (4) development and specification of engineering and administrative controls where required;
- (5) establishment of a proactive medical surveillance program applying SOTA monitoring techniques incorporating pulmonary function testing to detect early changes with greater sensitivity than using chest radiographs alone (chest radiographs reveal later-developing changes);
- (6) the wearing of approved respiratory protection for tasks performed when exposure levels were expected to exceed the accepted, "time-weighted average" concentration;
- (7) recordkeeping; and
- (8) training (hazard awareness) – and later more requirements were added consistent with the developing state-of-the-art and Federal and Navy requirements.

70. The Navy controlled exposure to asbestos consistent with the then current state of accepted scientific and medical knowledge balanced by needs for national defense. Sailors did not have the option to avoid exposure to asbestos-containing products or environments in which asbestos was used while on active duty. Certainly, Navy vessels built and/or overhauled in the 1940s through the 1970s often contained large amounts of asbestos which covered steam-driven equipment and thousands of feet of thermal-insulated pipes. These insulated lines traversed the entire vessel including non-engineering work spaces, as well as eating and berthing spaces.

71. In light of the Navy's knowledge regarding the potential asbestos-related health hazards from exposure since the 1920s (well before the large increase in specification by Navy designers, architects, and engineers), and the known military and technologic benefits or advantages afforded by the use of asbestos as thermal insulation and in other applications, the Navy made an informed decision to use asbestos-containing products. The Navy was fully cognizant of potential

health hazards when it specified use of asbestos in applications critical to national defense and the conduct of war. To insure that the health of military and civilian personnel was maintained, the Navy established a sound, premier state-of-the-art occupational health program to control the recognized, potential health hazard.

72. To carry the concept involving the offering of a written warning by an equipment manufacturer further, as the Navy had determined what an "acceptable asbestos exposure" was, the Navy would not, nor could not, allow each sailor to make an additional determination of what constituted an acceptable exposure on an individual basis. This is not only true for determining whether or not one would accept an asbestos exposure, but also all of the dozens of other daily potentially hazardous exposures (including to an armed enemy) that confront personnel. Navy specifications or instructions, as well as my decades of experience as an officer rising to the rank of Navy Captain, do not support the notion that manufacturers of equipment were free to provide additional warning information about hazards associated with products – especially those (like insulation) that they typically neither manufactured nor supplied.

73. Based upon review of many documents regarding the Navy's hazard communication program, and based on my career experiences as an Industrial Hygiene Officer and a physician in the Navy dating back to 1972, and personal knowledge of the Navy's hazard communication program and Naval practices generally, it is indisputable that uniformity and standardization of any communication, and in particular safety information, are crucial to the operation of the Navy. The Navy had a sound, occupational health and safety program based upon its requirements and conducted in accordance with Navy regulations, instructions, and operational necessities. Simply, the Navy could not operate if various personnel were trained differently and received additional, inconsistent information from different manufacturers.

74. For example, SECNAV Instruction 5100.8 ("Uniform Labeling Program - Navy, 26 September 1956) – which is an internal Navy directive from the Secretary of the Navy directing Navy personnel, not manufacturers of material or equipment, of the manner in which to carry out their obligations – Para.1 states: ***"The purpose of this instruction is to standardize labeling requirements for hazardous chemical products during usage..."***

75. Further to this goal of standardization, the Navy itself undertook the responsibility of developing, promulgating, and enforcing safety precautions for equipment maintenance. Indeed, the instructional manual provided to all new Navy Sailors (Bluejackets' Manual, 1965) provided:

"Your CO has been assigned safety as one of the functions of his command. He, your XO, your department head, division officer and petty officers are required to see to it that their men are instructed in appropriate safety precautions. These officers are required to make sure that each of their men know and practice safety precautions.

...

Navy Bureaus and Offices study the equipment for which they are responsible and then publicize the safety precautions to be followed. Safety precautions that are instrumental in avoiding preventable accidents and maintaining a healthy work environment have been gathered into a publication entitled 'Safety Precautions, Department of the Navy.'"

These Navy safety instructions referenced (Department of the Navy Safety Precautions, NAVSO P-2455, 1965) in this Bluejackets' Manual specifically set forth the Navy's official procedures for asbestos safety:

“Exposure to asbestos dust is usually encountered in the installation, repair, and removal of insulating pipe covering used principally aboard ship. The following precautions should be taken in any dust making operations involving asbestos products:

a. Provide permanent general ventilation in areas where dust producing operations are usually performed.

b. Install exhaust hoods over saws and other dust making machine tools.

c. Require workers to wear dust respirators where dusty operations cannot be adequately ventilated.

d. Use industrial vacuum cleaners in lieu of dry sweeping of floors and other surfaces.”

As discussed previously, as the state-of-the-art of asbestos hazard awareness developed within the medical and scientific community, these procedures were repeatedly superseded by ever more sophisticated Navy asbestos safety policies (NAVSHIPSINST 5100.26: “Control of Asbestos Hazards”, COMNAVSHIPSYSCOM, 1971; Naval Ships Technical Manual, Ch. 9390: “Thermal Insulation, Safety Precautions for Asbestos,” 1972; OPNAVINST 5100.19: “Safety Precautions for Forces Afloat, CNO, 1973; COMNAVSEASYSYSCOM, 1975).

76. In contrast, the Navy promulgated detailed specifications regarding the content of equipment manufacturer technical manuals – with specific examples of safety instructions that should be included (Military Specification – Technical Manuals for Mechanical and Electrical Equipment, MIL-M-15071 (SHIPS)). Similarly, the Navy promulgated detailed specifications for the form and content of information plates to be displayed on shipboard equipment (Military Specification – Identification Plates, Information Plates and Marking Information for Identification of Electrical, Electronic, and Mechanical Equipment, MIL-I-15024 (Ships). These two specifications specifically governing the content of written materials – including safety instructions dealing with operation and maintenance – to be provided by military equipment vendors are both completely silent regarding asbestos. However, such countless equipment manuals, identification/information/markings provided under contract terms by numerous manufacturers were reviewed, accepted, and used by the Navy for decades. It is obvious that these were not the methods nor instruments chosen by the Navy to control exposure to airborne asbestos fibers--this was a health-related matter addressed and controlled via another preferred route.

77. Indeed, any additional warning about the hazards of asbestos by an equipment manufacturer – beyond those already provided and enforced by the Navy – would have been only partial in scope, as well as inherently redundant and possibly inconsistent with the Navy’s own position and training. In the heat of battle, there is simply no time to be interpreting inconsistent hazard labels.

78. It has been my understanding, which has been supported by my experience, that literally all Navy sailors serving on ships in the WWII era and through the late 1960s knew and/or assumed that the high temperature thermal insulation used on naval steam system pipes and equipment contained “asbestos”. The exact type and composition of the thermal insulation may not have been known, but the use of asbestos for such application was so universal that identification of external thermal insulation on such hot steam system lines and equipment that the insulation was usually assumed to be “asbestos” – even in instances where it was replaced with fibrous glass, mineral wool, or other non-asbestos materials, or used as a minor component in an “85% Mag” product (85% magnesia:15% “asbestos”). This was still the practice when I was commissioned in 1972. As a fundamental aspect of Navy training and practice, dust control and a high level of general cleanliness, even in the engineering spaces, were routinely maintained as part of the standard Navy shipboard environment--spaces were kept “shipshape”.

79. At most, an equipment manufacturer could merely have told personnel to follow the Navy's own mandates for handling asbestos. Potentially redundant information is not informative, and diverts attention from hazards inherent in the equipment, and would certainly become obsolete. For example, the life expectancy of propulsion equipment onboard ship is many years, while military specifications and program emphasis (such as the Navy's asbestos hazard communication program) change much more frequently and have evolved over the years to keep pace with scientific developments and changes in materials. Static warnings about asbestos hazards provided with equipment intended to operate for decades would have been outdated and inaccurate almost immediately.

80. There are additional, sound reasons why the Navy did not want unsolicited and potentially inconsistent warning information from equipment manufacturers regarding asbestos insulation (or any other product) which was provided by other vendors or contractors. If every equipment manufacturer (and conceivably even the pipe and structural steel manufacturers) provided its own warning about asbestos insulation that might be used on or around its product, inconsistent warnings from these various sources would certainly have resulted. And, keep in mind, many other hazardous substances (e.g. boiler feed water chemicals, fuels, solvents, heavy metals) are used in conjunction with the multitudes of equipment on a ship. If each was to warn about all the possible substances that might be used on or around its equipment, sailors would quickly become inundated with inconsistent information on a myriad of substances.

81. Moreover, materials like external thermal insulation are periodically removed and replaced, and some types of insulation used by the Navy on equipment were non-asbestos (e.g., fiberglass blankets). Warning about asbestos on equipment where insulation – initially asbestos in the 1940s or 50s – was later replaced with non-asbestos insulation – in the 1960s or 70s – would simply be wrong. Military specifications for thermal insulation over time allowed an assortment of materials – as determined by a number of critical design and materiel availability parameters. As early as 1952, MIL-I-16411A addressed a non-asbestos thermal insulation felt that was suitable for use on steam turbines and other machinery and equipment operating at temperatures to 1,200°F – if selected by the naval design engineers and builders. After delivery of the equipment, how would the equipment supplier know what insulation material would be used in future repairs, overhauls, and conversions made one, two, or more decades in the future?

82. MIL-M-15071D, para. 3.3.1 makes it clear that equipment manufacturers' manuals must first be approved by the Bureau of Ships and ***the "manual shall not be modified without approval of the Bureau of Ships."*** Thus the Navy and/or its agents reviewed and approved the content of all equipment vendor manuals. In all cases, it was the Navy that exercised final discretion over what warnings to provide, or not provide, in equipment technical manuals. Moreover, it cautions: ***"Notes, cautions, and warnings should be used to emphasize important critical instructions. The use should be as sparing as is consistent with real need."*** This specification applies to risks inherent in the operation of the equipment; unsolicited and gratuitous warnings about the possible use of materials made and sold by others do not comport with this specification. The concepts of "safe", "hazardous", and "toxicity" have changed over the past decades. Specifically, as late as 1964, the American College of Chest Physicians in its treatise on "Asbestosis" noted: ***"Asbestos is not currently considered a toxic substance since it does not produce systemic poisoning."***

83. Lastly, but importantly, equipment manufacturers are not subject matter experts regarding the health effects or industrial hygiene controls associated with the use of asbestos-containing insulation materials in naval applications. It is unreasonable to speculate that the Navy would have accepted "helpful comments" from a vendor or equipment manufacturer concerning a material or substance provided by another vendor or supplier in which it was not a subject matter expert. And in any event, the Navy already had this specific expertise, and more – and understood its own basis for specifying asbestos-containing products onboard ship. The Navy already had a robust and encompassing occupational health program, working in concert with the Navy's operational, engineering, and maintenance and repair facilities, that far exceeded just the

mere labeling of a material. This program included aspects appropriate for the degree of recognized hazard at various times including training, engineering controls, medical examinations, provision of personal protective equipment, and the use of alternative products when possible. It is thus not surprising that the Navy, with its inherent authority used its discretion, consistently reviewed and approved manuals for thousands of pieces of shipboard equipment without redundant - and potentially inaccurate and conflicting - "asbestos warnings".

84. The naval or military setting is unique and distinct, and although management structure is generally similar, the command hierarchy of rank is well-defined and the authority of the Commanding Officer approaches absolute. This authority is based in Federal statute, as well as in Navy Regulations and Instructions. Over time, there have been evolutionary changes in these to incorporate changing societal values, but the authority of the individual in command remains constant. When routine "orders" are given, prompt and appropriate response is expected. The failure to obey a lawful order is a punishable offense, and depending upon the situation (war time, national emergency, misconduct), the punishment can be severe. Individual freedoms that are common to civilians are not as universally applied to military members, or even civilians working onboard Navy ships in Federal and private shipyards. Civil liberties indeed exist, but they are tempered to the strict Uniform Code of Military Justice (UCMJ) and the requirements for national security. To suggest that a government contractor supplying equipment used in a critical shipboard propulsion system had the autonomy to place whatever instructions it wanted onboard Navy warships, or other naval vessels - as simply as commercial manufacturers might add a label to a consumer product - is misleading and false.

PRIVATE EMPLOYER RESPONSIBILITIES

85. Prior to the enactment of the Occupational Safety and Health Act of 1970, the universally-recognized occupational exposure level in the United States for airborne asbestos particles (not fibers) was 5 million particles per cubic foot (5 MPPCF) or equivalent to approximately 30 fibers per cubic centimeter (30 f/cc). This level had been previously widely-accepted by health professionals and regulators in the United States since the late 1930s.

86. When OSHA first regulated asbestos in 1971 under authority of section 6(a) of the Occupational Safety and Health Act, it also adopted this value which existed as the Federal standard for asbestos under the Walsh-Healey Public Contracts Act. On May 29, 1971, the initial OSHA Permissible Exposure Limit (PEL) of 12 fibers per milliliter (or cubic centimeter ("12 f/cc" greater than 5 microns in length by phase contrast magnification)), or "equivalent" of 2 million particles per cubic foot ("2 MPPCF" by impinger samples counted by light-field techniques) was published. An "Emergency Temporary Standard (ETS)" for exposure to "asbestos dust" was promulgated on December 7, 1971, which reduced this value to 5 f/cc (with a 10 f/cc ceiling limit not to exceed 15 minutes in 1 hour for up to 5 hours/day). This ETS was in response to a petition by the Industrial Union Department of the American Federal of Labor-Congress of Industrial Organizations (AFL-CIO). The major shipyard workers' unions were affiliates of the AFL-CIO.

87. In June 1972, OSHA promulgated these limits in a final rule: "Standard for Exposure to Asbestos Dust" (DoL, 1972). The control of asbestos exposure to US workers was one of the five "Target Health Hazards" established under OSHA: (DoL, 1972b)

"Focusing upon the need to create healthful working conditions, the Occupational Safety and Health Administration in January 1972, initiated the Target Health Hazards Program. The emphasis is on five hazardous workplace substances:

1. **ASBESTOS**
2. **LEAD**
3. **SILICA**
4. **COTTON DUST**
5. **CARBON MONOXIDE** [EMPHASIS ADDED]

WHAT ARE APPROVED LEVELS? OSHA's permissible level is 5 fibers per milliliter greater than 5 microns in length for an eight-hour, time-weighted average airborne concentration. This may be increased to 10 such fibers per milliliter for no more than 15 minutes per hour, up to five hours per eight-hour day. Imminent danger situations are generally not applicable. Any exposure greater than permissible levels for unprotected or improperly protected workers is considered a serious violation."

88. In July, 1976, the OSHA PEL for asbestos was decreased from 5.0 f/cc to 2.0 f/cc; the ceiling concentration remained the same at 10 f/cc. At that point in time, even with a lower Permissible Exposure Limit, operators of equipment in typical shipboard settings and those operating and maintaining equipment which incorporated bound or non-friable asbestos materials were not, under normal working conditions, expected to be at risk of exposure to asbestos dust levels in excess of the existing Permissible Exposure Limit. These Federally-mandated permissible exposure limits (and corresponding Navy-directed occupational exposure limits), as well as all of the requirements for an "asbestos program" were in effect throughout the United States – and, of course, in a unionized shipyard facilities. In 1986, with considerable "fanfare", OSHA further reduced the Permissible Exposure Limit to one-tenth of its previous value – the Permissible Exposure Limit became 0.2 f/cc. This statutory limit remained in effect until 1994, when the Permissible Exposure Limit was further reduced to its present value of 0.1 f/cc. During the development and evolution of the "Asbestos Standard" over time, the National Institute for Occupational Safety and Health (NIOSH) provided the scientific and medical "technical" support to OSHA; NIOSH was staffed with commissioned officers and civilians working for the Public Health Service. To the extent that specific working conditions at a specific workplace did create a risk based upon the airborne concentration of asbestos fibers and other use and exposure parameters, the Navy, as well as Federal laws, initially the WHPCA and "Safety and Health Regulations for Ship Repairing", and later OSHA, the duty of educating, protecting, and warning the worker fell explicitly upon the employer (or the Commanding Officer in the Navy or Coast Guard) – as well as the manufacturers of the asbestos materials at issue.

89. Additionally, the new environmental release and disposal requirements under the Environmental Protection Agency's (EPA) "National Emission Standard for Hazardous Air Pollutants for Asbestos (Asbestos NESHAP)" in 1973 also had to be concomitantly fulfilled. (US Congress, 1970b; EPA, 1973) As discussed elsewhere in this report, the evolving "Asbestos Standard" and other statutory requirements enacted under the Occupational Safety and Health Act applied to the Navy and the Coast Guard via a series of Executive Orders; they were implemented by a series of specific Departmental and service instructions which were carried out via the Commander/ Commanding Officer and chain-of-command. Processes and conditions which were "military unique" were specifically excluded; however, general Navy and private shipyard operations were directed to be consistent with OSHA and EPA requirements as they pertained to the handling, use, management, storage, and disposal of asbestos-containing materials.

90. Because of the risk created from having a large number of workers and a large amount of asbestos-containing materials present, civilian shipyards were specifically-targeted industries for the OSHA and EPA regulators regarding all aspects of asbestos use, handling, and disposal. Additionally, inspecting officials of the US Coast Guard, as well as privately employed individuals working in shipyards and onboard ships during construction, repair, or overhaul, were subject to the provisions of the Occupational Safety and Health Act. OSHA inspectors could go onboard

vessels for inspections, but they were equally concerned about all shipyard safety and health conditions.

91. Any safety and health program must surely "start at the top" and include all levels of employees including management. The Navy's (and all US Governmental Departments' and Agencies') overarching Safety and Health Program includes and involves all levels of personnel from the highest levels of command (management) and supervision to the "deckplates" – the entry-level and unskilled enlisted and civilian personnel in the Navy Department.

92. As discussed throughout this report, the Navy had its own occupational health program which started before— well before the Occupational Safety and Health Act of 1970 (OSHA) – and continues to this date operating independently under Department of Defense Directives now as the Navy's Safety and Occupational Health Program. The Navy's program to control asbestos has always been the "State-of-the-Art ". As discussed previously, prior to the enactment of OSHA in 1970 and its statutory implementation in 1971, employment conditions at private facilities, such as shipyards and other industrial sites, were regulated under state and local laws, and, where applicable, Federal legislation ("Minimum Requirements" (1942) – updated for shipyards through the periodically revised and amended requirements of the Walsh-Healey Public Contracts Act (1936) and the "Safety and Health Regulations for Ship Repairing" (DoL, 1960)). The "Safety and Health Regulations for Ship Repairing" enacted in 1960 (DoL, 1960) state:

"... safety and health regulations that have been determined by the Secretary of Labor to be reasonably necessary to protect the life, health and safety of employees engaged in longshoring, ship repairing, and related employments covered by Section 41 of the Longshoremen's and Harbor Workers' Compensation Act, as amended."

These regulations were mandatory with respect to employers. Similarly, the numerous asbestos control requirements and health program aspects under OSHA were specifically directed to the employer and the workplace – not equipment manufacturers or suppliers. The scope of the OSHA asbestos regulations for employers was vast and the requirements were very specific. In a manner similar to the position accepted and taken by the Government, the employer, or controller of the workplace, had full responsibility for the control of occupational health hazards arising in or from the workplace. Under OSHA, it is the employer that has responsibility for providing a workplace that is free from recognized hazards (US Congress, 1970) and following the asbestos dust standards (DoL, 1972). Each employee also had responsibilities.

"(a) Each employer –

(1) shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees;

(2) shall comply with occupational safety and health standards promulgated under this Act.

***(b) Each employee shall comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to this Act which are applicable to his own actions and conduct."* [EMPHASIS ADDED]**

OSHA was enacted:

"To assure safe and healthful working conditions for working men and women; by authorizing enforcement of the standards developed under the Act; by assisting and encouraging the States in their efforts to assure safe and healthful working conditions; by providing for research, information, education, and training in the field of occupational safety and health; and for other purposes."

93. It was the employer, not the manufacturer of equipment used in a workplace, who was given the responsibility to control exposure to respirable asbestos fibers. Any worker's excessive occupational exposure after the enactment of OSHA was a likely result of a failure of the employer's specifically OSHA-mandated comprehensive asbestos control program (or the Navy's program), and not from any purported lack of a warning by equipment manufacturers and suppliers.

CONCLUSIONS

94. As discussed throughout this report, the US Navy had a longstanding program to prevent excessive exposure to airborne asbestos fibers based upon the best available knowledge – it was the state-of-the-art. This program was initially directed at preventing the only known illness directly caused by excessive exposure to inhaled asbestos fibers – the clinical disease called "asbestosis". The association between this clinical disease "asbestosis" (not merely "exposure to asbestos") and lung cancer was not generally accepted until Doll's published work in 1955. The disease "mesothelioma" was not associated with different exposure conditions to one type of asbestos (crocidolite) until Wagner's publication in 1960. Until the middle of the 1960s, the development of mesothelioma was also associated only with the presence of asbestosis. Lastly, it was not until 1972 that exposure to amosite asbestos was demonstrated to cause mesothelioma by Selikoff and his coworkers. The Government's initial program was directed at preventing lung fibrosis – asbestosis-the recognized precursor of lung cancer and mesothelioma during that period. That was the state-of-the-art practiced throughout the Nation and the world at that time. After the late 1960s, the Navy and the remainder of the Federal Government paralleled the statutory requirements of the Occupational Safety and Health Act – and in many instances the Navy had more strict requirements which had to be met by the "operational Navy".

95. Throughout the time periods discussed herein – but especially for all occupational exposures after the enactment of the Occupational Safety and Health Act of 1970 – the employer and controller of the workplace was required to have an effective program for the control of exposure to regulated asbestos-containing materials. It was the employer and the employee – not the equipment manufacturer, that were responsible for safety and health in the workplace. For realistic delivery of OSHA-mandated workplace occupational safety and health programs at industrial facilities, all levels of management and supervision were involved. The Navy not only closely followed this mandate, it stood as a model for control of exposure and modification of the workplace. The Navy's "first-level supervisors" were the Chiefs and senior Petty Officers, and they were extremely important in monitoring the day-to-day adherence to mandatory safety and health regulations – while accomplishing the Navy's essential mission in National defense. The control of occupational exposure to asbestos was one of the five national "Target Health Hazards" established by OSHA in 1972. It was the Navy's "Number One" occupational safety and health program – starting in early 1971 with a redoubling of prior efforts. Environmental controls dealing with the content, labeling, handling, and disposal of asbestos-containing materials were also established under the Environmental Protection Agency (USEPA, 1973, 1975, 1976). The operational Navy also followed these requirements.

96. The presence and content of asbestos in various materials, including thermal insulation, gaskets, packings, and other materials used in naval, marine, and industrial applications, were variable, but generally decreasing over the period of the 1950s through the 1970s. Additionally, the friability of these materials varied considerably. Unless a material is qualitatively and quantitatively analyzed in a scientific manner, the presence, type, and concentration of asbestos cannot be determined in either the material or in the air. The release of friable asbestos fibers into the air can only be determined through sampling and analysis of air samples. The mere "observation" that one can see a large particle of dust does not confirm that respirable-size asbestos fibers of any significant concentration would be inhaled. Visible dust is not necessarily "respirable" dust – and "respirable" dust is not necessarily all asbestos. Duration and frequency of exposures are also important in assessing asbestos exposure. From the industrial hygiene

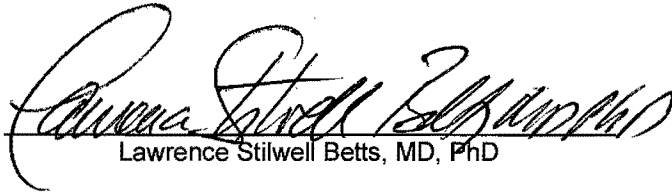
standpoint of controlling potential hazardous inhalation exposure to asbestos, it may be assumed that much of the thermal insulation and other materials, such as gaskets and packings, used in the construction and maintenance of naval vessels, as well as industrial facilities, contained asbestos during the era of the 1940s through the mid-1970s – and later; however, only proper analysis and determination by trained and qualified individuals are scientifically conclusive. Without such evaluation, it cannot be known whether, and to what extent, the products and the “dust”, purportedly identified by individuals not trained and not utilizing applicable industrial hygiene methods, actually contained asbestos.

97. Based upon my decades of experience as an industrial hygienist and physician in the Navy, as well as the available scientific and medical literature and known incidence of former Navy personnel with asbestos-related diseases, it can be stated with some certainty that personnel working in Naval and private shipyards and onboard Navy ships during the 1940s through the 1960s, and sometimes even into the 1970s, experienced what is today understood to be clinically meaningful exposures to asbestos dust – from both the general background level onboard a Navy vessel of the era, as well as when performing tasks on thermally-insulated surfaces. During this time period, the scientific and medical data indicated that controlling inhalation of asbestos fibers to levels below those which caused asbestosis effectively guarded personnel from the subsequent development of asbestos-related cancers. Typical shipboard exposure levels of this era were not considered to be excessive or causally involved with the development of asbestos-related lung disease by the contemporary occupational health professionals. The largest, and most significant, source of friable asbestos fibers from thermally-insulated surfaces onboard ships of those periods would be the pipecovering on the thousands of feet – literally miles – of piping. It is practically impossible to make any other definitive statement regarding the specific source(s) of a particular individual's significant exposures to respirable asbestos fibers onboard ship. More importantly, using the ungrounded and unsubstantiated assumption that each and every fiber contributes to the development of a cancer and actually causes the cancer is – from a scientific standpoint – meritless. The probabilistic “cause” in the development of a cancer, such as malignant mesothelioma, is based upon the source(s) that meaningfully contribute to an individual's effective “dose” – the dose is the amount which contributes to the risk that the “causal fiber” will reach the target cell and cause uncontrolled or unabated cellular changes which actually lead to the cancer. In retrospect, it must be realized that there were an extremely huge number of these individual asbestos fibers in the air using the scientifically-based, recommended exposure values developed and accepted by the scientific and medical communities, and used by the Navy and numerous other federal agencies and states during these various periods. The initial occupational exposure level of 5 MPPCF (30f/cc) equates to 1,059,300,000 asbestos fibers in each cubic meter of inhaled air (5 MPPCF x 6f/MPPCF x 35.31 cu ft/cu m); this equates to over 8 billion fibers inhaled daily (x 8 cu m/day max inhaled) by an individual before the enactment of the Occupational Safety and Health Act in 1970. The currently mandated OSHA Permissible Exposure Level of 0.1 f/cc (greater than 5 microns in length) for asbestos has been in effect since 1994. Under this PEL, there can still be up to 100,000 such sized fibers in each cubic meter inhaled, and up to 800,000 fibers can inhaled each day. Identifying the likely source of the causal fiber was, and remains, difficult and practically impossible. Also, it must be noted that not every asbestos fiber in an asbestos-containing material is released (friable) or inhaled (breathed in). Furthermore, not every fiber which is inhaled is “respirable” (brought into the lungs) and retained in the body, and finally reaches the site where the tumor develops. If each and every asbestos fiber contributed to the development of malignant mesothelioma, then one would expect the presence of many individual tumors arising from the enormous number of inhaled fibers. Generally, in the vast majority of cases, to the extent there exists any identifiable source of significant exposure to respirable airborne asbestos fibers onboard any ship of an era, including the general ship-wide background levels, the external thermal insulation on the piping would be that source – and by far the largest amount of friable asbestos material used onboard ships of the corresponding era.

98. Federal Department s and Agencies, such as the Navy, Coast Guard, Public Health Service, and Labor, had total control over its hazard communication program at all times relevant to this

discussion, including control over the content – and methods of delivery – of safety instructions and warning provided to personnel. The Government exercised its discretion in this respect by balancing the priorities of operational necessity, the health and safety of personnel, as well as other practical and logistical considerations. The Navy, in particular, itself implemented a state-of-the-art occupational safety and health safety program that included asbestos. It thus chose to provide consistent, uniform instruction to sailors and shipyard workers, rather than delegating the task to a myriad of vendors with incomplete information, no control of the workplace, little knowledge of mission requirements, and who were not subject matter experts on asbestos hazards. It is unreasonable to conclude that the Navy would have appreciated or accepted gratuitous advice from equipment manufacturers about hazards associated with products (like insulation) that they did not manufacture, and about which the Navy was already well aware. Finally, in light of all the evidence regarding the Government's existing knowledge and robust program to prevent exposures, and other Federal and state regulations requiring the protection and education of employees, it is impossible to imagine how a mere warning on a piece of metal equipment or product could possibly have meaningfully affected personal actions, and precluded exposures to airborne asbestos fibers, years and often decades, after the product was sold.

99. My scientific and medical opinions stated herein are based upon my education and training as a scientist and as a physician; my personal and professional experiences as a certified industrial hygienist and a board-certified occupational medicine physician; my operational and industrial experiences from my total Navy career; my research and review of historical documents regarding the Navy's knowledge as well as the scientific and medical communities' knowledge of the hazards of asbestos; and my communications with industrial hygienists and physicians who worked for the Navy and Public Health Service dating back to the early 1940s. These opinions are all stated within a reasonable degree of scientific, medical, and professional certainty.


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12 Apr 2013
Date

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